

# A Saxon Fish Weir and Undated Fish Trap Frames Near Ashlett Creek, Hampshire, UK: Static Structures on a Dynamic Foreshore

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**Abstract** The remains of a wooden V-shaped fish weir and associated structures have been discovered near Ashlett Creek on the tidal mudflats of Southampton Water in Hampshire, southern Britain. Radiocarbon dating of oak roundwood stakes taken from the main weir structure date it to the middle Saxon period. Clusters of as-yet undated roundwood posts within the catchment area of the weir are interpreted as the frames for fish traps that are assumed to pre- or post-date the operational period of the weir itself. The weir is contemporary with wooden V-shaped fish weirs found elsewhere in southern and central Britain, and also Ireland, but its circular catchment ‘pound’ remains restricted, in these islands, to the Solent and Severn estuaries: it has a close parallel with another Saxon-era weir on the nearby Isle of Wight. It also shows striking structural similarities with examples in use today in Basse Normandy, on the southern shore of the English Channel. The paper discusses the function and operation of the weir, and places it in its social and historical context. Regressive cartography demonstrates that the structures have become exposed as a result of saltmarsh retreat in this area of Southampton Water since the nineteenth century. The radiocarbon dates returned for the posts demonstrate that this transgression of the marsh must have been preceded by a prolonged period of progradation, which covered and preserved the site; its subsequent re-exposure has negative implications for its survival.

**Keywords** Fish weir · Southampton Water · Saxon · Intertidal · Saltmarsh

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## Introduction

Fish weirs are permanent static fishing structures, built from wood, stone, or sometimes concrete, that are erected in the coastal intertidal zone or on a river course. They function by using long barriers, known as ‘leaders’, to marshal fish moving with the tide or current into a zone of concentration—the ‘pound’—where they are trapped and collected by hand or net. Tidal fish weirs are most commonly oriented to trap fish on the ebb tide, with the catch stranded as the sea recedes. Fish traps, meanwhile, are much smaller, funnel-shaped baskets that are anchored in the water, often on a wooden frame, in order to trap migrating fish.

Clearly, the remains of static fishing structures help shed light on the past exploitation of marine resources by the people and communities who constructed them. However, since they were built to function within a very particular environmental niche—that is, on the lower foreshore, within the intertidal zone—they may also serve as datums, particularly if they can be securely dated, against which change in this often very mutable zone can be measured (Allen 2002). Hence, they have the potential to inform issues of much broader concern than solely the historical, such as climate change, sea-level rise and coastal erosion. This is particularly useful in estuaries of great ecological and economic importance such as Southampton Water in Hampshire, on Britain’s south coast, where the fishery structures reported here are located (Fig. 1).

In March 2005, at dusk approached on a low spring tide, the authors were walking the salt marshes and mudflats of Southampton Water between Calshott Spit and Ashlett Creek, on the western shore of the estuary, when they came across a line of roundwood posts and associated wattle protruding from the mud, close to the low-water mark. Further investigation by the authors in full daylight revealed that these traced the outline of a V-shaped fish weir, with a circular catchment pound at its apex. In addition, separate structures—interpreted as frames for holding individual fish traps—were noted within the area bounded by the weir’s leaders (Figs. 2, 3). The structures were surveyed and recorded within their landscape context, and sample posts extracted for recording. Eleven years later, the first-named author made a further visit to the site in April 2016 to take samples for radiocarbon dating and species identification.<sup>1</sup> The results and contextualisation of both these activities are reported here.

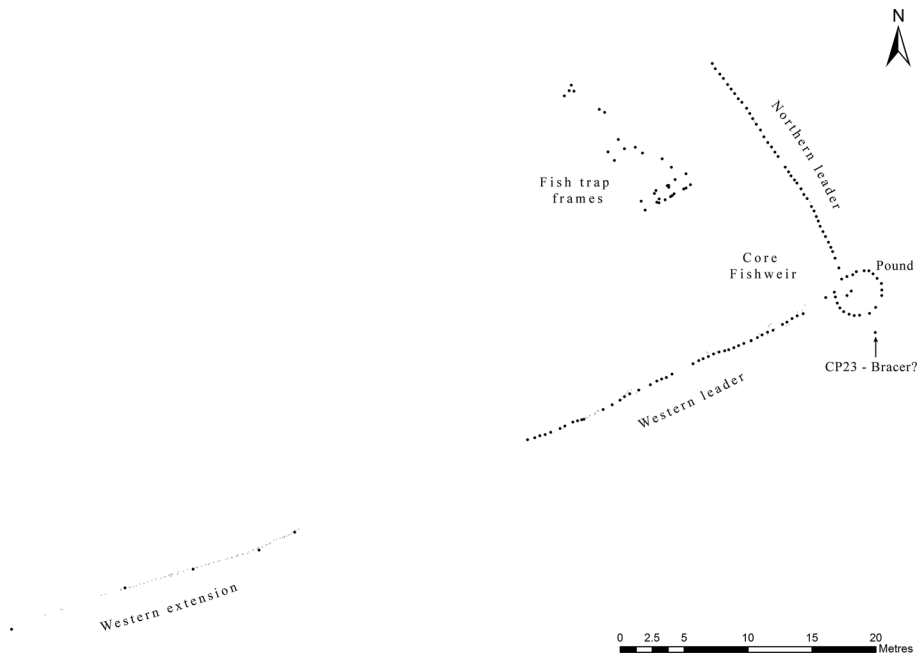
## Fish Weirs and Traps: an Archaeological Turn

Scholarly interest in static coastal fisheries has surged in recent decades. The reasons are several, but in part must be attributed to a burgeoning interest in the intertidal zone in general, as well as to a growing awareness of their existence, form and potential antiquity. The global and chronological distribution of such structures is impressive (McGrail 1983: 36, 39–46; Desse-Berset and Billard 2012: 13–17; Billard 2016a: 23–31). Outside of our area of focus, illustrative (though not exhaustive) archaeological and ethnographic examples may be cited from other parts of Europe (Jankó 1900; Sirelius 1906; Antipa 1916; Viveen et al. 2014), North America (Byram 1998; Tveskov and Erlandson 2003; Connaway 2007; Caldwell 2008), Africa (White 1956; MacLaren 1958; Avery 1975;

<sup>1</sup> We are grateful to Dr Julian Whitewright and Dr Fraser Sturt for their assistance in relocating the site, obtaining wood samples for radiocarbon dating and species identification, and surveying the contemporary location of the saltmarsh edge.



**Fig. 1** The location of the Ashlett fishery site (*Upper image* and annotation: J.P. Cooper; *lower image* basemap: Crown Copyright and Database Right 2016. Ordnance Survey (Digimap Licence) 1:10 000 Scale Raster [TIFF geospatial data], Scale 1:10000, Tiles: su40se, su40sw, Updated: 22 March 2013, Ordnance Survey (GB), Using: EDINA Digimap Ordnance Survey Service, <<http://digimap.edina.ac.uk>>, Downloaded: 2016-10-10 15:46:59.025)



**Fig. 2** Site plan of the Ashlett fishery structures (Image: the authors)



**Fig. 3** The fishery structures at Ashlett, looking west from seaward of the pound. The core Saxon fishweir's circular pound (Ø 3.5 m) and trajectories of the leaders are highlighted in *yellow*, the area of fish-trap frames in *pink*, and the possible bracing post in *blue*. The Fawley oil refinery is visible in the background (Image: J. P. Cooper) (Color figure online)

Gribble 2005), the Arabian–Persian Gulf (Sergeant 1968; Carter and Killick 2010; Al-Abdulrazzak and Pauly 2013), East Asia (Chen 1976; Jeffreery and Pitmag 2010; Zayas 2011; Jeffrey 2013), Australia (Dargin 1976; Bowen 1998; McNiven et al. 2012; Kelly 2014), and the Pacific (Cobb 1901: 427–433; Alexander 1902; Legendre 1912; Nishimura 1975). In chronological terms, the use of standing fishing technologies has been identified as early as the Mesolithic, for example in Zealand, Denmark (Pederson 1995, 80–82) and the Liffey estuary, Ireland (McQuade and O'Donnell 2007), Neolithic examples are known

from Wootton Quarr, England (Loader et al. 1997, 12) and Begschenhoek in the Netherlands (Louwe Kooijmans 1987: 238–242).

With their extensive coastlines and large tidal ranges, the islands of Britain and Ireland, together with the Breton and Norman coasts of France, have proven particularly rich in evidence of standing fisheries. Scholarly investigation of these began earliest in Ireland and Wales. In the former, pioneering and mostly ethnographic documentation was conducted across much of the republic by Went (1946a, 1946b, 1948, 1969) and in Northern Ireland by Mitchell (1965). Subsequent archaeological work by O’Sullivan and colleagues since the early 1990s has identified fish weirs on the Shannon, Fergus and Deel estuaries of the west of Ireland (O’Sullivan 1994, 1995, 1997, 1999, 2001: 135–232; 2003, 2005; Dillon and O’Sullivan 2008; Daly 2014; Sands et al. 2016), as well as in Strangford Lough (O’Sullivan et al. 1997; McErlean and O’Sullivan 2002). Montgomery et al. (2015) have also recently reported structures in Lough Swilly, Co. Donegal. To this list should be added the already mentioned Mesolithic fishtraps of the Liffey. In Wales, early research was conducted by Lewes (1924) in Cardigan Bay; Senogles (1969) and Jones (1983) in the Menai Straits; Momber (1991) in Caernarfon Bay; and Jenkins (1974: 31–43) across several locations. They were followed in the Severn Estuary by Godbold et al. (1994), who were among the first archaeologists to carry out excavations in the intertidal zone. By the turn of the millennium, Welsh surveys had identified 71 sites (Turner 2002: 96). Particular concentrations are notable in Milford Haven (Turner 2002: 99), the estuaries of Carmarthen Bay (Page 1996a, b, 1997; James and James 2003) and the Severn estuary (Godbold et al. 1994; Nayling 1996; Allen and Bell 1999; Nayling 1999a, b; Bell et al. 2000; Allen 2002; Brown et al. 2007).

Work on standing fisheries in Scotland has been slower in reaching publication, despite Bathgate’s early attempt (1949) to draw attention to the subject in the wake of Went’s Irish work. But many have been at least identified. Bathgate cites a weir at Loch Broom, Ross and Cromarty, and signals others at Invershin and Culrain on the Kyle of Sutherland, and on the Dornoch, Cromarty and Beaully Firths. Much of what has been done since Bathgate focuses on the major estuaries of the north east, in particular the Moray and Cromarty Firths and the Firth of Forth where numerous fish weirs have been identified: Cressey and Hale (1998) identified 62 ‘fish-traps’ in their survey of the inner Moray Firth (see also Hooper 2001); Hale (1998, 2005) reports at least one in the Cromarty Firth, and Robertson (1996) and James (1996) identified 17 in the Firth of Forth (Dawson 2004: 40–44). In the west, Paula and Colin Martin have identified a number in northern Argyll (Martin 2008).

Published research on England has focused on the major estuaries of the south. Indeed, for the most part, it has echoed Welsh interest in the Severn estuary and Bristol Channel, with standing fishing structures in wood and/or stone identified in Somerset and the Levels (McDonnell 1980; Dennison 1985; Aston and Dennison 1988; Hildich 1998; Allen 2004; Rippon 2004; Brunning 2007; Chadwick and Catchpole 2012; Catchpole et al. 2013), in Gloucestershire (Jenkins 1975: 45–46; Moore-Scott 1993; Rowbotham 1993; Townley 1998; Brown et al. 2005; Allen and Haslett 2006; Crowther and Dickson 2008; Chadwick and Catchpole 2012), and as high upriver as Shropshire (Pannett 1988). The Severn structures include V-shaped fish weirs and also fish traps of Saxon date (Chadwick and Catchpole 2012: 58–62, 66; Brunning 2007: 70–74; Catchpole et al. 2013: 3, 5). In North Devon, Preece (2005: 139–165) reports wooden V-shaped fish weirs from cartographic and textual sources and archaeological survey in the Taw and Torridge estuaries, while Davis (1958: 25, 28) reports V-shaped salmon weirs at Barnstaple and Lynmouth. In the south of the county, fish weirs or traps have been noted in the Exe, Erme and Avon estuaries (Hegarty et al. 2014: 125–128; Pink 2016: 65). Davis (1958: 25, 28) also reports stone tidal fish ponds in the Yealm estuary. In south east England, a series of early and middle Saxon-era fish weirs have been identified in



the Blackwater estuary in Essex (Gilman 1998; Strachan 1998; Hall and Clark 2000; Ingle and Saunders 2011) and on the Thames in west London (Cohen 2003, 2008a, b, c, 2011; Greenwood 2008; Wharton 2008a, b), while fish traps have been identified in the wider Thames estuary (Paddenberg and Hession 2008, 146, 148–149). Closer to the Ashlett structures, on the Isle of Wight, is the already mentioned Neolithic fish weir at Wootton Quarr, a late Saxon one at nearby Binstead (Loader et al. 1997: 22; Tomalin et al. 2012: 217–221), and another of slightly later Saxo-Norman date on Ryde Sands at Springvale/Seaview Duver (Loader 2008: 6). A series of around five early, middle and late Saxon fish weirs have also been identified in the foreshore at Holme-next-the-Sea in Norfolk—unusually, not in an estuarine context (Brennand and Taylor 2003: 9–10; Robertson and Ames 2010). Finally, a Saxon and a Norman weir have been discovered on the River Trent at Colwick, Nottinghamshire (Losco-Bradley and Salisbury 1988). Further marine fishery structures have been recorded in England—for example off Cleethorpes in Lincolnshire and Morecambe Bay in Lancashire (Jecock 2011)—but these have not been published in detail. Davis (1958: 30–32) also reports contemporary examples at Dungeness, Rye and Dimchurch in Sussex, and on the Ravenglass estuary in Cumbria, although these were net-based, and operated only seasonally.

Standing wooden and stone fishery structures across the English Channel are also relevant to our discussion, particularly with reference to form and construction. Billard and colleagues (Billard (ed.) 2012; Billard et al. 2013; Billard and Bernard (eds) 2016) have carried out extensive research on archaeological and modern fish weirs on the coasts of Normandy, while Langouët and Daire (2009) have reported the existence of some 570 structures of various types along the length of the northern and southern coasts of Brittany.

## Fish Weir Types

Typologies of shore, estuary and river fish weirs found in Britain and Ireland offered by Salisbury (1991) and Bannerman and Jones (1999) gives a sense of the range of configurations employed in static fishery structures. Given the underlying principle of weirs as devices that gather and concentrate prey into a small trapping area for collection (Davis 1958: 25–26), the ‘V’-type arrangement seen at Ashlett is, unsurprisingly, common. These ‘V’s may occur singly, as at Ashlett, Binstead (Loader et al. 1997: 22), and London (Cohen 2003: 13), with several more examples on the Blackwater estuary, and at Bunratty and Strangford Lough in Ireland (O’Sullivan 1997, 2005; O’Sullivan et al. 1997; McErlean and O’Sullivan 2002). But they may also form part of complex arrays, such as at Morecambe Bay and Cleethorpes (Davis 1958: 27; Jecock 2011: 2–3), Swansea Bay (Nayling 1999c), Magor Pill (Nayling 1999b) and at Collins Creek on the Blackwater estuary, where the structures have been estimated to comprise 13,000 posts (Gilman 1998: 276).

Where shorelines were plentifully supplied with rocks, trees were relatively sparse in the immediate hinterland, and the substrate was able to bear heavy weights and people carrying them, weirs could be often constructed of stone, for example at Loch Broom (Bathgate 1949) Minehead (Aston and Dennison 1988: 401) the Menai Straits and Caernarfon Bay (Senogles 1969; Jones 1983; Momber 1991). However, in large, muddy estuaries, such as the Shannon, Severn, Thames, and Blackwater, the Firth of Forth, and the tidal flats of Normandy, construction in wood was favoured. In such cases, wood could be sourced locally, carried across treacherous mudflats with relative ease, and fixed in the mud. It is into this category that the Ashlett weir fits.

Table 1 and Fig. 4 summarise the locations of fish weirs and traps in Normandy, Britain and Ireland that are comparable in either date or form to the Ashlett fish weir.

**Table 1** Wooden fish weirs/traps/baskets in Britain and Ireland of comparable date to the Ashlett structure

| Weir (by country)                                | Date (AD)               | Source  | Pound shape  | Leader dimensions (m) |                    | Post spacing (approx) |
|--|-------------------------|---|--------------|-----------------------|--------------------|-----------------------|
|  |                         |   |              | Left <sup>a</sup>     | Right <sup>a</sup> |                       |
| England  |                         |   |              |                       |                    |                       |
| Blackwater Estuary—Collins Creek                 | AD 650–990              | Strachan 1998: 275–276; Hall and Clark 2000; O'Sullivan 2003: 464 | Funnel       | 2550                  | 275                | 0.5                   |
| Blackwater Estuary—The Nass                      | AD 664–882              | Strachan 1998; O'Sullivan 2003: 464                               | Funnel       | 135                   | 104                | ?                     |
| Blackwater Estuary—Sales Point                   | AD 672–896              | Strachan 1998: 279–280  | Funnel       | 340 <sup>b</sup>      | 290 <sup>b</sup>   | ?                     |
| Colwick—Nottinghamshire                          | AD 662–880              | Losco-Bradley and Salisbury 1988: 329–338                         | ?            | ?                     | ?                  | 0.5                   |
| Holbrook Bay, Suffolk (STU067)                   | AD 680–850              | Everett 2007: 6–9   | Round?       | 180                   | 310                | ?                     |
| Holbrook Bay, Suffolk                            | AD 880–1025             | Everett 2007: 9   | ?            | ?                     | ?                  | ?                     |
| Holme Beach, Norfolk (Fishtrap No. 85; HER38043) | AD 250–890              | Brennand and Taylor 2003: 3, 10; Robertson and Ames 2010: 336     | ?            | –                     | 33.6               | ‘Random’              |
| Holme Beach, Norfolk (Fishtrap No. 72; HER38042) | AD 420–900              | Brennand and Taylor 2003: 3, 9–10; Robertson and Ames 2010: 336   | ?            | 38.5                  | 33                 | ?                     |
| Holme Beach, Norfolk (HER38222)                  | AD 820–1030; AD 640–810 | Robertson and Ames 2010: 336; 333–336                             | ?            | 12.5                  | 13.5               | ?                     |
| Holme Beach, Norfolk (HER39586)                  | AD 640–810              | Robertson and Ames 2010: 336                                      | ?            | 22                    | 62                 | 0.2                   |
| Holme Beach, Norfolk (HER37613)                  | AD 430–670              | Robertson and Ames 2010: 332–333, 336                             | ?            | 16                    | 35                 | 0.15–6.3              |
| Isle of Wight—Binstead                           | ca. tenth c. AD         | Loader et al. 1997: 22  | Funnel       | ?                     | ?                  | ?                     |
| Severn—Aust/Oldbury Flats (10021)                | AD 650–775              | Chadwick and Catchpole 2012: 62, 66                               | ?            | ?                     | ?                  | ?                     |
| Severn—Aust/Oldbury Flats (10032)                | AD 1025–1280            | Chadwick and Catchpole 2012: 62, 66                               | ?            | ?                     | ?                  | ?                     |
| Severn—Aust/Oldbury Flats (10039)                | AD 660–780              | Chadwick and Catchpole 2012: 62, 66                               | ?            | ?                     | ?                  | ?                     |
| Severn—Beachley, Glos. (10343)                   | AD 770–970              | Chadwick and Catchpole 2012: 58–61, 66                            | Round (ø1 m) | ?                     | ?                  | ?                     |

**Table 1** continued

| Weir (by country)                              | Date (AD)                  | Source                              | Pound shape  | Leader dimensions (m) |                    | Post spacing (approx)        |
|--|----------------------------|-------------------------------------|--------------|-----------------------|--------------------|------------------------------|
|  |                            |                                     |              | Left <sup>a</sup>     | Right <sup>a</sup> |                              |
| Severn—Stert Flats (Saxon trap, no. 201)       | after AD 932               | Brunning 2007: 70–71                | Funnel       | 30                    | 30                 | ?                            |
| Severn—Stert Flats (Trap no. 203)              | after AD 966               | Brunning 2007: 71                   | ?            | ?                     | ?                  | ?                            |
| Severn—Stert Flats (Trap no. 204)              | AD 680–1040                | Brunning 2007: 72                   | Funnel       | 17                    | 34                 | ?                            |
| Severn—Stert Flats (Trap no. 205)              | ca. tenth–thirteenth c. AD | Brunning 2007: 73–74                | Funnel       | 28                    | 14                 | ?                            |
| Severn—Stert Flats (Trap no. 309)              | ca. seventh–tenth c. AD    | Brunning 2007: 74                   | ?            | ?                     | ?                  | ?                            |
| Severn—Stert Flats (Trap no. 10271)            | AD 1030–1160               | Catchpole et al. 2013: 3, 5         | ?            | ?                     | ?                  | ?                            |
| Severn—Woolaston (10328)                       | AD 830–990                 | Chadwick and Catchpole 2012: 61, 66 | ?            | ?                     | ?                  | ?                            |
| Solent—Binstead, Isle of Wight (B48/100)       | AD 810–1040                | Tomalin et al. 2012: 217–221        | Round        | 66                    | 128                | 1.6                          |
| Solent—Springvale/Seaview Duver, Isle of Wight | AD 1040–1260               | Loader 2008: 5–6                    | Round        | 40                    | 28                 | ?                            |
| Southampton Water—Ashlett                      | AD 680–895                 | This article                        | Round        | 69                    | 33                 | 0.5 (core)/4.7 (W extension) |
| Thames—Barn Elms                               | “Early Anglo-Saxon”        | Cohen 2003: 12                      | ?            | ?                     | ?                  | ?                            |
| Thames—Putney                                  | “Early Anglo-Saxon”        | Cohen 2003: 12                      | ?            | ?                     | ?                  | ?                            |
| Thames—Barn Elms                               | “Middle Anglo-Saxon”       | Cohen 2003: 12                      | ?            | ?                     | ?                  | ?                            |
| Thames—Chelsea                                 | AD 730–900                 | Cohen 2003: 12                      | Funnel       | 4.8                   | 7.5                | 1.2                          |
| Thames—Iselworth                               | AD 650–890                 | Cohen 2003: 12                      | Rectangular? | 25                    | 22.6               | 0.85                         |



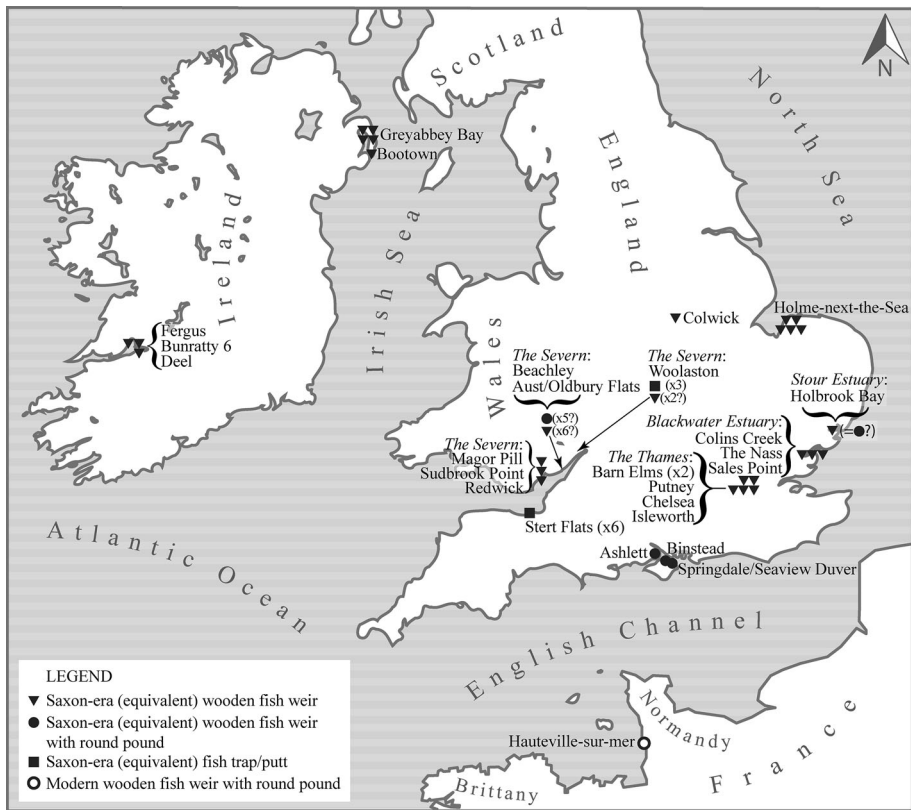
**Table 1** continued

| Weir (by country)                                  | Date (AD)          | Source   | Pound shape         | Leader dimensions (m)         |                    | Post spacing (approx) |
|--|--------------------|--|---------------------|-------------------------------|--------------------|-----------------------|
|  |                    |  |                     | Left <sup>a</sup>             | Right <sup>a</sup> |                       |
| Wales  |                    |  |                     |                               |                    |                       |
| Severn—Magor Pill                                  | AD 623–45          | Allen and Rippon 1997                                  | (Putt weir)         | n/a                           | n/a                | n/a                   |
| Severn—W of Sudbrook Point (Context 238)           | Eighth–tenth c. AD | Godbold et al. 1994                                    | (Fishweir hurdles?) | ?                             | ?                  | ?                     |
| Severn—Redwick                                     | AD 425–655         | Allen and Bell 1999                                    | (Fish trap?)        | n/a                           | n/a                | n/a                   |
| Ireland (NI and Republic of)                       |                    |  |                     |                               |                    |                       |
| Deel estuary—I                                     | AD 1041–1208       | O'Sullivan 1995, 2003: 464; 2001: 144–147              | ?                   | 5.5                           | 10.5               | 0.43                  |
| Fergus estuary—east 2                              | AD 442–644         | O'Sullivan 1994, 2003: 464; 2001: 138–144              | ?                   | 8.2 (only one leader visible) | 0.25–0.35          |                       |
| Shannon estuary—Bunratty 4                         | AD 1017–1155       | O'Sullivan 1997, 2001: 138–144; 159–164                | Opening             | 12                            | 2                  | ?                     |
| Strangford Lough—Bootown                           | AD 1037–1188       | McErlean and O'Sullivan 2002: 158                      | Rectangular         | 200                           | 200                | ?                     |
| Greyabbey Bay, Strangford Lough—South Island       | AD 1023–1161       | McErlean and O'Sullivan 2002: 158                      | Rectangular         | 200                           | 200                |                       |
| Greyabbey Bay, Strangford Lough—Chapel Island East | AD 685–773         | McErlean and O'Sullivan 2002: 158–162; O'Sullivan 1997 | Opening             | 27                            | 146                | 0.5                   |
| Greyabbey Bay, Strangford Lough—Chapel Island East | AD 771–889         | McErlean and O'Sullivan 2002: 158; O'Sullivan 1997     | ?                   | ?                             | ?                  | ?                     |
| Greyabbey Bay, Strangford Lough—Chapel Island West | AD 783–979         | McErlean and O'Sullivan 2002: 158; O'Sullivan 1997     | ?                   | ?                             | ?                  | ?                     |

Dates are the broadest range indicated by radiocarbon-dated samples

<sup>a</sup> As viewed from the apex

<sup>b</sup> This fishweir is square, being designed to catch fish on both the ebb and flow tides



**Fig. 4** Map of Southern Britain, Ireland and northern France showing fishweirs and traps of comparable date or form—in the case of Hauteville-sur-Mer—to the Ashlett fishweir (Image: J.P. Cooper)

## Site Topography

The Ashlett structures are located in the mudflats of the western shore of Southampton Water, about 1 km east–north–east of the small settlement of Ashlett, and close to the modern mean neap low tide level (Fig. 1). In its upper reaches, the inter-tidal zone comprises salt marsh that is cut through by meandering channels. The marsh terminates at its seaward end with cliff of 0.5–1 m in height, below which are mudflats comprising deep Holocene mud deposits and occasional shelly berms. These tidal wetlands support large populations of migratory, overwintering and feeding birds, making the area of international ecological importance (Burgess 2000). Today the intertidal zone lies within the Hythe-to-Calshot-Marshes Site of Special Scientific Interest (SSSI) and also the Southampton Water and Solent Special Protection Area (Natural England 1994; Joint Nature Conservation Committee 2001).

In contrast to this picture of ecological richness, this part of Southampton Water shoreline is also heavily industrial. About 1 km to the north of the fishery site is the UK's largest oil refinery, ExxonMobil's 330,000-barrel-a-day Fawley plant, together with associated petrochemical facilities. The marine loading facilities of the complex come within 750 m of the fishery structures. The Fawley power station, which until its closure in

2013 was fuelled by pipeline from the refinery, lies a similar distance to the south–southwest. Immediately inland, new woodland grows through the concrete aprons of a wartime storage depot. The main shipping channel of Southampton Water is less than 1 km to the east. The coastal landscape surrounding the site is therefore strategically significant from both an environmental and economic perspective.

The structures were found protruding out of a deep layer of largely inorganic, consolidated and horizontally bedded Holocene blue–grey pyritic clays. These clays lie up to up to 20 m deep in the immediate vicinity (Hodson and West 1972: 421–429), and up to 25 m deep around nearby Calshot Spit (Dyer 1980, 20, 23). Calshot Spit itself is of Pleistocene origin, and because of the protection it provides against waves driven by the prevailing south–westerly winds, the build-up of the Holocene clays within this area of Southampton Water has largely kept pace with relative sea-level rise since the early Flandrian period, when the sea began flooding the Pleistocene Solent River drainage system of which the Southampton Water formed part (Allen and Gibbard 1993; Antoine et al. 2003: 235; Everard 1954; Hodson and West 1972: 430, 435; West 1980: 8, 12–13). Eustatic sea-level rise has been accompanied by a degree of isostatic subsidence associated with post-glacial rebound (Lambeck 1993; Peltier et al. 2002; Shennan et al. 2006; Shennan and Horton 2002).

## The Structures

The fishing structures comprise arrangements of roundwood posts and occasionally associated wattle eroding out of the Holocene clay downslope of the saltmarsh edge (Figs. 2, 3). At the time of the original 2005 survey, the posts stood up to 18 cm—but on average 7 cm—proud of the substrate. There were signs on some posts of attack by gribble (*Limnoriidae* Sp.) and shipworm (*Terredo navalis* Lin.), suggesting that exposed posts were prone to deterioration, and therefore cannot have been exposed for long. A visit to the site in April 2016 to obtain wood samples for carbon dating and species identification revealed far fewer visible posts than in 2005: in the intervening time, the ground surface had changed from largely exposed Holocene clay to a widespread covering of broken shell fragments, suggesting that some of the posts had been reburied, or in some cases had been eroded away.

The posts formed three distinct elements. The first, closest to the mean low-water mark, is referred to as the ‘core fish weir’. At its centre was a series of posts forming a circle around 3.5 m in diameter, with a 1.2 m-wide opening. This opening was the object of convergence of two relatively straight lines of posts, set at 90° to each other. One of these (the ‘western leader’) ran for 26 m in a southwest-by-westerly direction, while the other (the ‘northern leader’) ran northwest by north for 19.7 m (Figs. 2, 3). The second element, lying slightly higher in the intertidal zone, is referred to as the ‘western leader extension’. It comprised a line of posts running for 14.8 m in continuation of the alignment of the western leader of the core fish weir, but separated from it by a gap of some 19 m. The third element of the site comprised a group of posts found within the area enclosed by the leaders of the core fish weir, and referred to hereafter as the ‘fish trap frames’: it is identified, albeit tentatively, as the remains of a number of supporting frames for individual fish traps, with a suggestion of a short leader between them.

The shape traced by the posts of the core fish weir clearly identifies it as such: this would probably have originally been marked out by creating a shallow furrow along which

the posts would have been driven into the substrate (Duhamel du Monceau 1769: 1.2.84). On completion, its two leaders would have funneled fish returning to open water on the ebb tide into the entrance of the pound. Two posts set about 60 cm apart within the circle of the pound, about 1 m from the entrance, probably anchored the ends of two hurdles that acted as a ‘no-return’ feature, allowing fish into the pound, but making it less likely that they would find their way back out. It is of course unknown whether the surviving length of the weir’s leaders reflect their original full extent: the visible portion of the northern leader in particular stopped just short of a shell berm, which may or may not conceal further posts. Of the two posts extracted whole from this structure, one (WP29; Fig. 5) was embedded over 90 cm into the present ground level, and the other (NP02; Fig. 6) 30.5 cm. Penetration of a 1.5-m-long auger into the clay at intervals along the line of one of the leaders encountered only clay, and identified no stone footing to the weir—a feature found on other weirs (Went 1951; Loader et al. 1997: 22; Bannerman and Jones 1999: 74, 78–79; Nayling 1999a; Tomalin et al. 2012: 219). This partly reflects the amenability of the stiff clay substrate to the deep driving of posts, rendering the use of supporting stones unnecessary (Duhamel du Monceau 1769: 1.2.83), but also the local scarcity of suitable rocks.

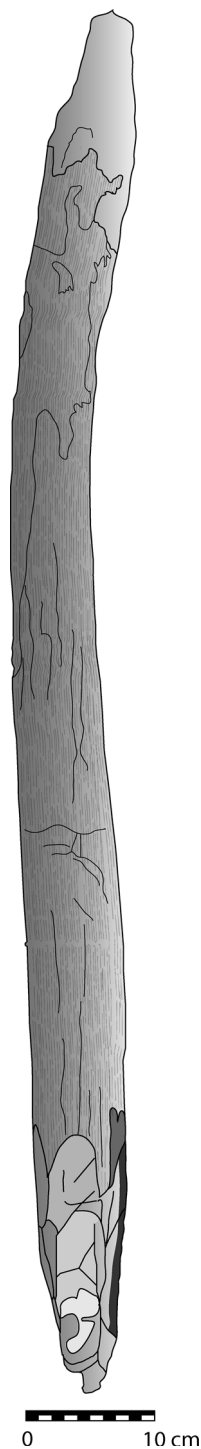
The core fish weir displayed a consistent construction technique throughout. The posts, typically ranging from 5–10 cm in diameter, were spaced an average 48 cm apart—a distance close to the traditional cubit. Evidence of wooden wattle was found during the 2005 survey at various points along both leaders of the weir and around its pound. An exposed and relatively coherent wattle assemblage near the western end of the western leader of the core fish weir revealed something of its structure: the vertical elements, or sails, were typically 2 cm in diameter, occurred singly, and were spaced 10–15 cm apart, while narrower horizontal rods, typically 1.5 cm in diameter, were woven around them, again singly: not enough rods were exposed to establish the original spacing between them. The wattle lay along the inner face of the leader, such that the force of the ebbing tide would have braced it against the supporting posts (Fig. 7). It is worth noting in this regard that ebb-tide currents in Southampton Water are typically twice as strong as the flood (Sharples 2000: 50; Ribeiro et al. 2004). It is probable that the wattle constituted part of structurally discrete hurdles, rather than having been woven around the posts themselves. Such an arrangement would have made manufacture, repair and replacement of the wattle elements considerably easier, since the hurdles could be made onshore, and simply carried and fastened in place at low tide. It would also have allowed seasonal removal of sections of the leader (see below).

Despite being in alignment with the western leader of the core fish weir, the posts comprising the western extension indicate a quite different construction method. Here the main supporting posts were spaced much further apart, at an average 4.7 m, or about five paces (Fig. 2).<sup>2</sup> Again, evidence of wattle was found between them, this time in the form of sails protruding from the substrate. Unlike in the lower structure, however, these sails occurred in pairs, rather than singly, with each pair set some 30–35 cm apart (Fig. 7). The double sails may reflect the additional strength required by the hurdles to resist the force of the current in the absence of more closely spaced supporting posts. The two posts extracted from this section intact were found to be embedded to relatively shallow depths into the clay—18 cm (WP48) and 21 cm (WP51) respectively (Table 2). Both had been sawn at their lower end, rather than sharpened to a point. The possible reason for this is discussed below.

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<sup>2</sup> Assuming a missing post in one case.

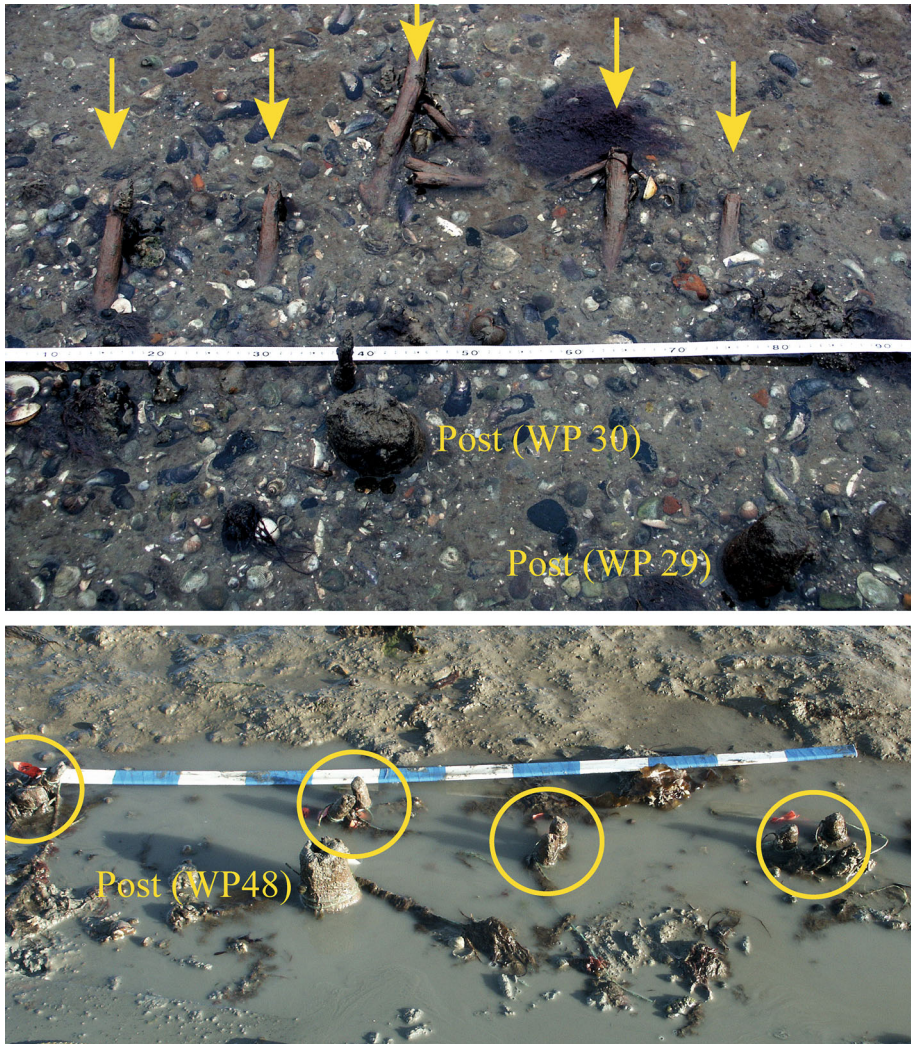
**Fig. 5** Line drawing of roundwood post WP29 excavated from the western leader of the core fishweir; note the large tool marks (see Table 2) (Image: J.P. Cooper)





**Fig. 6** Photograph and line drawing of oak roundwood post NP02 excavated from the northern leader of the core fishweir (see Tables 2, 3). Note the large tool marks (Image: J.P. Cooper)





**Fig. 7** Sections of visible wattle from the core fishweir (*above*) and western extension (*below*) eroding from the substrate. Note the single sails (indicated with *arrows*) of the core weir's wattle, and the double sails (*circled*) of that of the western extension. The scale of the *upper image* is in centimetres; the subdivisions in the lower scale are 5 cm (Image: J.P. Cooper)

The posts of the putative fish trap frames were distributed over an area running just over 12 m in a broadly NW–SE direction, and almost 5 m in a SW–NE direction (Fig. 2). Little pattern can be distinguished in the distribution of many of the posts, perhaps because they were the remnants of incomplete frames. However, they tended to constitute small clusters, each of which is interpreted as the remains of the frame for a single fish trap. They do not form linear alignments that would lend themselves to an interpretation that they constitute the remains of a discrete fish weir—or indeed an array of fish traps forming a ‘putt weir’ or ‘putcher weir’ such as that reported by Jenkins (1974: 47–54) and Turner (2002) on the Severn estuary. Rather, two parallel rows of posts, about 0.8 m apart, could be discerned

**Table 2** Dimensions and characteristics of timbers extracted from the site

| No                              | From structure    | Material                   | Length (mm) | Of which, exposed (mm) | Diameter (mm) | Tool marks            | Complete to end? | Form at end |
|---------------------------------|-------------------|----------------------------|-------------|------------------------|---------------|-----------------------|------------------|-------------|
| Extracted during 2005 fieldwork |                   |                            |             |                        |               |                       |                  |             |
| WP29                            | Core fishweir     | Wood                       | 1091        | 150                    | 95            | Large billhook or axe | Yes              | Spire point |
| WP48                            | Western extension | Wood                       | 280         | 100                    | 100           | Saw                   | Yes              | Flat/sawn   |
| WP51                            | Western extension | Wood                       | 250         | 40                     | 55            | Saw                   | Yes              | Flat/sawn   |
| MP08                            | Putt frames       | Wood                       | 595         | 145                    | 80            | Small billhook or axe | Yes              | Spire point |
| MP09                            | Putt frames       | Wood                       | 321         | 115                    | 90            | Saw                   | Yes              | Flat/sawn   |
| MP13                            | Putt frames       | Wood                       | 131         | 50                     | 55            | Small billhook or axe | Yes              | Spire point |
| Extracted during 2016 visit     |                   |                            |             |                        |               |                       |                  |             |
| WP13                            | Core fishweir     | Wood ( <i>Quercus</i> sp.) | n/a         | 120                    | 55            | –                     | No               | –           |
| CP15                            | Core fishweir     | Wood ( <i>Quercus</i> sp.) | n/a         | –                      | 80            | –                     | No               | –           |
| NP02                            | Core fishweir     | Wood ( <i>Quercus</i> sp.) | 366         | 75                     | 78            | Large billhook or axe | Yes              | Spire point |

running along the SSE edge of the scatter, and it is this configuration, lying broadly perpendicular to the direction of the tide, that suggests these structures as the remains of frames that had once supported conical woven basket-traps of the type attested elsewhere, such as the Severn (Godbold et al. 1994: 23–27): comparable Neolithic and Iron Age structures are attested from Wootton Quarr and Binstead Beach (Tomalin et al. 2012: 198–199, 201–204). No in situ wattle or basketry was observed among these posts. If this interpretation is correct, then the remains of four or five fish trap frames can be discerned—three in the front row, one behind it, and the final one still further behind—perhaps with remnants of a leader to channel the catch towards them. The depths of the three posts extracted from this area in the contemporary clay varied between 8 cm (MP13) and 59 cm (MP08; Fig. 7; Table 2).

Ethnographic and archaeological studies of fish weirs elsewhere have noted the presence of bracing elements—oblique poles or pegged guy ropes—to shore up either the leaders or the pound against the forces of the tide. Examples may be cited from Normandy (Billard 2012: cover image; Billard et al. 2012a: 28–32; Chatelais et al. 2012: 110), Essex (Hall and Clark 2000: 136), Colwick (Salisbury 1981), Bunratty (O’Sullivan 2001: 171) and the Lower Bann (Mitchell 1965: 15). A single post (CP23) located about 1.7 m south of the pound edge may be evidence of the same at Ashlett (Fig. 2), but as only one such post was found, this interpretation is tentative.

## Radiocarbon Dating and Species Identification

Three posts were extracted from the core fish weir in April 2016 for radiocarbon dating and species identification (Table 3). Posts from the western extension and fishtrap frames could not be relocated during this visit, and so were not sampled: they were presumably buried, or perhaps had eroded away, in the intervening decade. Calibrated radiocarbon dating of samples from the extracted posts produced first-sigma dates of AD 720–40 and 765–895 for both posts WP13 and NP2, and AD 680–880 for post CP15.<sup>3</sup> These broadly eighth–ninth century AD dates place the posts squarely within the middle Saxon period. Since they overlap substantially, this may be reflective of a single construction event. However, even if this is the case, the weir would have required ongoing maintenance during its lifetime, and it is even possible that none of these posts date to the absolutely original construction (Bannerman and Jones 1999: 74; Hall and Clark 2000; O’Sullivan 2003: 452–3).

The same posts were species-identified to genus level as deciduous oak (*Quercus* Sp.): their archaeological context in southern England implies pedunculate or sessile oak (*Q. robur* or *Q. petraea* respectively) as the likely species. However, anatomical features of archaeological wood samples do not allow identification of deciduous oaks to species level.<sup>4</sup> Meanwhile, traces of bark observed in 2005 on some in situ posts of the northern leader were suggestive of birch (*Betula* sp.); visual inspection of several pieces of wattle on the western leader and western extension were suggestive of *Corylus* sp. These identifications are consistent with wood types used in fish weirs elsewhere in Britain. Hall and Clark (2000) identified *Quercus*, *Betula* and willow/poplar (*Salix/Populus*) among posts in

<sup>3</sup> At 95% probability. Radiocarbon dating was carried out by the Beta Analytic Radiocarbon Dating Laboratory, 4985 S.W. 74th Court, Miami, Florida 3315, U.S.A.

<sup>4</sup> Species identification was by Dr. Sara Rich of the Maritime Archaeology Trust on 19 May 2016, with confirmations by Dr. Roderick Bale and Prof. Nigel Nayling of the University of Wales, Trinity Saint David. We are grateful to these scholars for their assistance.

**Table 3** Radiocarbon (Radiometric plus) dates from fishweir timbers ('lower structure')

| No   | Material <sup>a</sup>       | Radiometric plus dates <sup>b</sup> |  |             |
|------|-----------------------------|-------------------------------------|--|-------------|
|      |                             | Conventional radiocarbon age (B.P.) | Calibrated result (95% Probability) (AD) | Lab. no     |
| WP13 | (Wooden post (Quercus sp.)) | 1200 ± 30                           | 720–40, 765–895                          | Beta-437122 |
| CP15 | (Wooden post (Quercus sp.)) | 1240 ± 30                           | 680–880                                  | Beta-437109 |
| NP2  | (Wooden post (Quercus sp.)) | 1200 ± 30                           | 720–40, 765–895                          | Beta-437110 |

<sup>a</sup> Species identification by Dr. Sara Rich, Maritime Archaeology Trust

<sup>b</sup> Calibrated using IntCal13 and Marine13 radiocarbon age calibration curves (Reimer et al. 2013)

Saxon weirs at Collins Creek in Essex, and these plus *Corylus* in the wattle hurdles. Catchpole et al. (2013: 13–18) identified oak, alder, and birch for posts at sites in the Severn estuary, and widespread use of willow in basket traps. The eighteenth century *Traité général des pesches* of Duhamel Du Monceau (1769: 1.2.84) reports that willow, poplar, birch, hazel “and other pliable woods” were used as wattle in the construction of wooden fish weirs in France at his time.

## Relationships Between the Structures

The difference in construction technique between the leaders of the core fish weir and the western extension raise the question of whether or not these constitute parts of the same fish weir. In favour of the proposition is the fact that the western extension and western leader of the core fish weir are clearly in alignment with each other. Against it is the fact that the construction techniques of each are quite different—in terms of the spacing of the posts, the tool used to cutting them (see below), and the construction of the wattle hurdles. The absence as yet of radiocarbon dates for posts from the western extension means that the question cannot be resolved at this stage by reference to absolute dating.

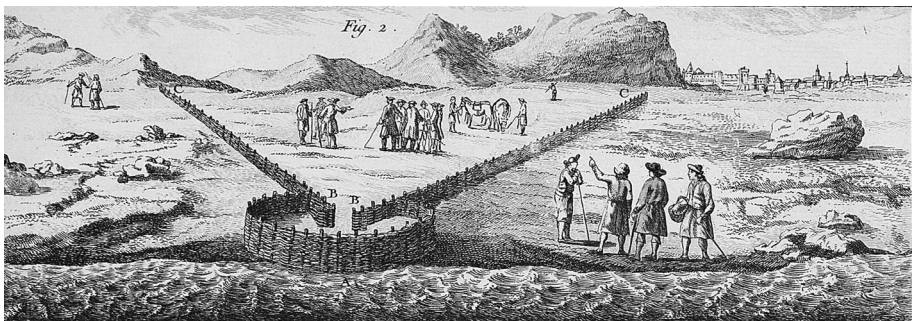
On its own, the shared alignment of the western extension and western arm of the core fish weir do not guarantee that the core fish weir and western extension are contemporary components of the same structure. It is possible that the western extension is rather the leader of an adjacent weir, the pound and other leader of which have been lost. This putative second weir might have been contemporary with the ‘core’ weir—but that leaves its divergent construction unexplained. Alternatively, it could belong to a different phase, with whichever was the later weir being built with reference to the visible remains of the other, and reflecting a communal familiarity with the behaviour of fish in the area. Such a time-deep interpretation implies a tradition of fishing on the site. As O’Sullivan (2003) observes, it might reflect an “archaeological” knowledge of the estuary among local fishing people who were expert in their own fishing grounds, and who were inspired to build there by the remnants they observed.

However, a comparison of the Ashlett site with fish weirs of similar structure operating in Normandy to the present day provides an ethnographic parallel that suggests the western extension and core fish weir might be part and parcel of the same structure after all. Billard



and colleagues (Chatelais et al. 2012: 111–113; Billard et al. 2012b: 90–95; Billard 2016b: 101–102) present a schema of a fish weir at Hauteville-sur-Mer, recorded in 1927, and photographs of another taken in 2004, which not only has a very similar round pound to that of Ashlett, but also leaders that change in their construction after a certain distance from the pound. The section of each leader that is closest to the pound is built like the pound itself: it comprises closely set posts between which are attached vertical and horizontal in-fill laths to close the gaps. Further from the pound, the construction changes: wattle is woven horizontally around the standing posts up to about 40 cm above the ground; higher than that, a much more open, arching weave is adopted. Drawing on this ethnographic parallel, the probable reasons for this change in construction can be interpreted twofold. First, in its original form, the Ashlett weir (like its French parallels) was probably tallest at the pound end, with the leaders diminishing in height as they progressed up the mudflats towards the high-water mark. Davis (1958: 25) describes modern-era English and Welsh weirs as being 8 ft (2.4 m) high at the pound, reducing to 3 ft (90 cm) at the end of the leaders. Duhamel du Monceau (1769: 1.2.83; 1.2. pl. 24, Fig. 1)—who also observed fish weirs with round pounds in France (Fig. 8)—also advises that those built in relatively sheltered waters may be 8–10 *pieds* (2.60–3.25 m) high at the pound, but that those in more exposed locations might reach no more than 3–4 *pieds* (0.97–1.30 m). In any case, the leaders would be made at a progressively lower height as they proceed up the intertidal zone to the high water mark while still effectively steering the fish towards the pound. They would, moreover, have been submerged for a shorter time, and in shallower water: this would have reduced both the force and the duration of the tidal currents acting against them, thus requiring a lighter structure. Second, in the ebbing tide it is likely that the core of the weir would have become the focal point not only for the desired fish, but also for detritus such as sediment and mobile vegetation, ranging from seaweed to tree branches. This core area would therefore have had to be strong enough to withstand the pressure of floating objects guided towards it by the leaders, and also to resist the pressure of water and materials building up behind it on the ebb tide—again, bearing in mind that the velocity of the ebb current in Southampton Water is typically twice that of the flood. People attending the weir to gather the catch would have had a secondary task of removing detritus that would threaten its structural integrity, and making repairs where it was compromised (Lewes 1924: 99).

Duhamel du Monceau offers a further reason for a difference in construction of the outer sections of the leaders relative to the core. First, the rods of the wattle in his French example are set further apart on the outer leaders—2–3 *pouces* (54–81 mm), compared to



**Fig. 8** Engraving of a French fishweir with round pound comparable to the Ashlett fishweir, from Duhamel du Monceau's *Traité général des pesches* (1765: 1.2 pl. 24)



**Fig. 9** Close-up of the posts of the core fishweir, western extension and fishtraps overlaid onto a georectified close-up of the 1898 Ordnance Survey 1:10,560 (Image: Posts surveyed by the authors; basemap Crown Copyright and Landmark Information Group Limited (2016). All rights reserved. (1898))

1.5–2 *pouces* (41–54 mm) in the core section—in order to allow fry ranging across the shallows to escape; second, these outer leaders are removed entirely in seasons of the year when fry proliferate (Duhamel du Monceau 1769: 1.2.83–84). This may also explain why the posts extracted from the western leader extension of the Ashlett fish weir had sawn ends rather than pointed stakes: they were not driven so deep into the substrate to the extent that they could no longer be easily removed, but rather were placed into shallower pre-excavated holes from which they could be extracted.

In the light of these ethnographic insights, it is probable that the western extension leader at Ashlett is indeed contemporary with the core weir: it was structurally lighter to allow removability and in order to ensure best use of resources by concentrating posts where they were most needed, and thinning them out where possible. Indeed, an explanation for the 19 m gap between the western leader of the core fish weir and the western extension can be discerned in the 1870, 1898 and 1930 Ordnance Survey maps of the saltmarshes (Fig. 9): superimposition of the geo-referenced fishery structures over the maps shows that a channel incising the saltmarsh cut through the weir at this point. Any posts that existed along this section would therefore have been exposed by the channel and destroyed.

Finally, if the proposed fish trap frames are correctly interpreted as such, then they cannot have been in operation at the same time as the core fish weir, since the catchment of the latter would have rendered the former redundant. Either the fish traps operated before the weir was built, or after it had fallen into disrepair.

## Tool Marks

Of the four posts extracted from the substrate of the core fish weir, two (WP 29 and NP02) had intact lower ends, and both had been sharpened to a spire point (Figs. 5, 6 respectively). The broad cut faces and long tool marks—up to 50 mm— suggest the use of a



relatively large iron tool such as a billhook or axe, characteristic of medieval and later periods.<sup>5</sup> In contrast, the two posts extracted from the western extension that had preserved lower ends (WP48 and WP51) had both been cut square with a saw: this clearly has implications for how, and particularly how far, these were driven into the substrate. Cut marks on the wattle of the core fish weir and western extension suggest that they were cut with a single slanting cut, suggestive of a large billhook. Finally, two of the three posts extracted from the fish trap frames (MP08 and MP13) had been sharpened to a point, and one (MP09) was cut square using a saw. The one fish-trap frame post that had been sharpened—MP08—had considerably smaller faces than those used on posts WP29 and NP02, suggesting the use of a much smaller or blunter tool, or perhaps a stone one (Fig. 10). The latter interpretation may be suggestive of a considerably earlier date, but the sawn ends of the two other posts from the fishtrap structures militates against such an interpretation. Clearly the dating of these traps frames merits further investigation.

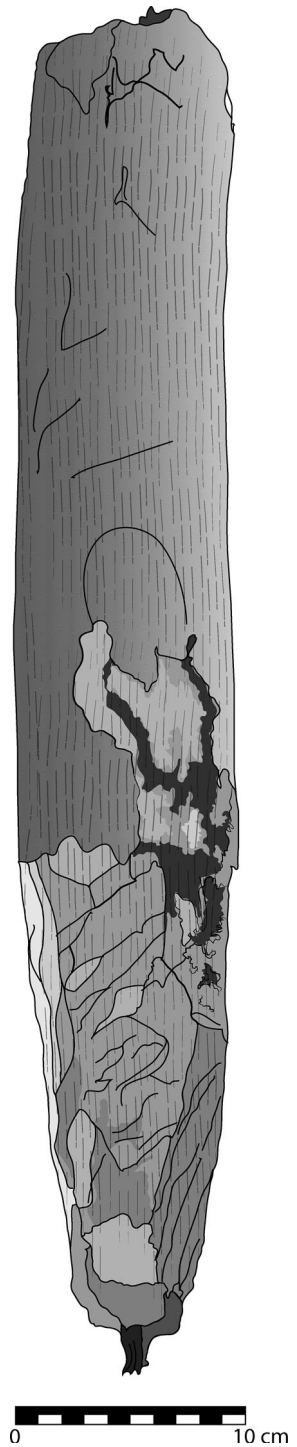
## Function and Operation

The Ashlett weir and traps are located close to the outlet of Ashlett Creek in the lower foreshore mudflats. Allowing for change in the course of the creek in the intertidal zone over time, it is possibly for this reason that the structures were located where they are: contemporary local topography would have determined the length and relative positioning of the leaders (Duhamel du Monceau 1769: 1.2.84). Fish move shoreward with the flood tide in search of food, especially towards the outlets of freshwater streams such as Ashlett Creek, which bring down nutrients from the land. They turn and head towards deeper water with the ebb (Davis 1958: 26; O’Sullivan 2003: 451; Gabriel et al. 2005: 199). Those that make their turn within the catchment area of the trap are guided by the leaders towards the pound. Since their instinct is to head for deeper water, the fish do readily turn around and seek an exit around the open ends of the leaders, which in any case will ultimately be left high and dry as the water recedes.

As today, the pound would have been set close to the low-water mark in order to maximise the area of foreshore within the catchment area (Duhamel du Monceau 1769: 1.2.84). However, the weir needed to be accessible to its operators on most tides—neeps and springs—and they needed enough time to empty and maintain it before the flood tide returned, so it was probably set closer to the low neep tide mark than that of the spring. The closed form of the pound of the Ashlett fish weir, with no mechanism apparent for disabling its trapping action, implies a fishery that was used all year round, and which was attended continuously by a nearby community. Such a structure would, once in place, catch fish on every tide. The catch would inevitably attract the attention of seabirds and poachers, and so would have to be closely guarded on each ebb. Nets or some kind of cover over the pound—for which there is of course no archaeological evidence—might have been deployed in order to afford some protection from the air: there are parallels for this in the twentieth century salmon ‘garths’ of Ravenglass, Cumbria (Davis 1958: 30). However, access to the pound cannot have been barred entirely without interfering with its function: effective fishing would therefore have required an anticipatory human presence at each low tide (Duhamel du Monceau 1769: 1.2.84–85), including nocturnal attendance, as recent ethnographic examples show (Chatelais et al. 2012: 112). Lewes in 1924 (399) reports the experiences of a Welsh fish weir keeper, Miss Davies: ‘[S]he had often to keep night

<sup>5</sup> We are grateful to Damian Sanders for his advice on the question of tool marks.

**Fig. 10** Line drawing of roundwood post MP08 from the putative fish-trap frame area. Note the many small tool marks of the point (Image: J.P. Cooper)



watches, alert with the lantern and net, that she might be ready when the tide receded to secure her haul.”

Another reason for being in immediate attendance was to release immature fish while there was still time. Indeed, it may well be that mature fish were actively killed—removed, speared or clubbed—before the last of the water left the pound (Gabriel et al. 2005: 199). Meanwhile, leaving the weir unattended for prolonged periods would have been problematic: without some way of disabling the trap, fish would have been caught in any case, needlessly depleting fish stocks and polluting the environment (Duhamel du Monceau 1769: 1.2.83–85; Davis 1958: 26–27). Duhamel du Monceau (1769: 1.2.84) recommends that fish weir builders leave a gap of 3 *pouces* (81 mm) between the lower edge of the wattle and ground level and cover it with a 1.5 *pouce* (41 mm) net or mesh to allow fry to escape, but he complains that few in his experience did.

## Historical Context

The eighth–ninth century dating of Ashlett’s core fish weir places it in chronological context with several V-shaped wooden fish weirs of Britain and Ireland (Table 1; Fig. 4). Many of these occur in southern British estuaries, notably the Severn, the Thames, the Blackwater, the Stour and the Solent. It is worth noting that the three Saxon/Saxo-Norman fish weirs found to date in the Solent and Southampton Water area have circular pounds. The Binstead and Ashlett weirs are directly contemporary. This picture suggests a morphological vernacular for Solent and Southampton Water fish weirs in the Saxon period that is distinct from other areas of Britain and Ireland. Round pounds have been recorded at Saxon weirs in the Severn at Beachley and Aust/Oldbury Flats (Chadwick and Catchpole 2012: 58–62), but these are typically only 1 m in diameter, and so remain distinct from the Solent and Southampton Water examples. The similarities that this style has with present-day fish weirs in Normandy is particularly intriguing given that the Norman monastery of Mont-Saint-Michel is known to have owned fish weirs on the south coast of England, in particular Exeter (Mollat 1967). Davis (1958: 29) makes reference to implicitly recent (i.e. mid-twentieth century) examples of a weir type with a round pound that ‘appears to have existed on the southern side of the Thames estuary’, but he does not identify or locate specific examples. The pronounced regional variation of fish weir types in Britain and Ireland has been highlighted by O’Sullivan (2003: 451, 462).

In more recent times, the ownership and operation of British fish weirs has often been associated with individual families, who either owned or leased the fishing rights from a local landowner (Davis 1958: 25; Jenkins 1974: 6; James and James 2003: 30–35). Before the Reformation, however, associations are known between these structures and medieval monastic institutions. The influence of Christianity on diet, and in particular its emphasis on fish during seasons such as Lent and Advent, when meat was forbidden, has been cited as a reason for widespread use of fish weirs, fish ponds, and similar devices in pre-Reformation Britain (Dyer 1988; Strachan 1998: 280; O’Sullivan 2003; Searce 2009: 7). Such ecclesiastical ownership arrangements extend back to the Saxon period: Bath Abbey’s estate at Tidenham in Gloucestershire, which the Abbey owned from AD 956 to AD 1060, contained 104 fish weirs (Dyer 1988: 78). Meanwhile while Strachan (1998: 279–280) has noted both the proximity of the Saxon fish weir at Sales Point in Essex to a nearby Saxon church and also Bede’s mention of a large monastery at Ythanchester, modern Bradwell, near the mouth of the Blackwater estuary. Other medieval monastic fish

weirs are known throughout Wales (Jenkins 1974: 34). Saxon ecclesiastical institutions close to the Ashlett fisheries that might lay claim to it include Romsey Abbey and the Old Minster at Winchester (Russel 2002: 22–23). In the early thirteenth century, meanwhile, there is record of the ownership by the Hospital of God's House in Southampton of a new foreshore fish weir at Dibden, less than 8 km along the shore from the Ashlett weir (Dyer 1988: 78–9; O'Sullivan 2003: 452, 456–458; Bannerman and Jones 1999: 75).

The nature of the ownership of the Ashlett fisheries is of course unknown. O'Sullivan (2003: 462) associates smaller fish weirs with secular communities, and the larger ones with monastic institutions. Certainly, as Heppell (2011: 93) observes, the quantities of wood required for immense fish weirs such as those of the Blackwater estuary imply the resources of a large estate. If O'Sullivan's characterisation is correct, then the Ashlett weir might be associated with a nearby settlement, such as at Ashlett itself, from which it could be regularly accessed on the receding tide. The toponym is of Saxon derivation, *æsce flete*, meaning 'the fast stream of the ash trees'. Evidence of nearby Saxon settlement includes All Saints church at nearby Fawley, and a saltern at Ashlett is described as being of 'possible early medieval date' (Wessex Archaeology 2010: 5.5.4, Appendix E, 2.1.10, 2.1.11, 2.1.16, 2.2.6). In any case, if the owners of the weir did not live at or near Ashlett, then its operators almost certainly did.

The widespread presence in Southampton Water of salterns of various dates alerts us to the possibility that some of the catch of the weir might have been salted for preservation and/or transportation further inland. Meanwhile the radiocarbon dates for the weir's posts suggest that it was contemporary with the heyday of Hamwic, the Saxon urban precursor to Southampton, which developed as a royal town with planned urban layout, a market and even its own mint (Morton et al. 1992: 26–29; Fig. 1). It may be that part of the output of the weir found its way, fresh or salted, to this important nearby market. Finally, in response to O'Sullivan's speculation about size versus ownership, it may be that the relatively small size of the Ashlett weir had more to do with the local topography of intertidal zone than its ownership.

Whatever the social constitution of the communities operating the Ashlett fish weir and traps, their members clearly had a territorial stake in the Ashlett intertidal zone, and the right to at least enough of the weir's output to warrant its upkeep. As O'Sullivan (2003) has argued, such an attachment to place carries with it connotations of identity, belonging, tradition, and memory in addition to technological and fishing expertise. Although Southampton Water has yet to yield a chronological depth in standing fishery structures to match that of the Blackwater and Severn estuaries or Strangford Lough, the Ashlett structures nevertheless point to a particular community with a local attachment, and an intimate knowledge of the habits of fish in the intertidal zone. Indeed, as O'Sullivan and Van de Noort (2005) explore, the temporal rhythms inhering in intertidal spaces not only determine work patterns—for example with respect to the function of the weir—but also, as O'Sullivan (2003: 466) notes, they may well have set its operators apart from other members of their community, such as agricultural labourers on adjacent fields, whose lives were governed by different rhythms.

Just why the Ashlett fishery structures fell out of use is unknown. In the thirteenth and fourteenth centuries—and indeed in the nineteenth—legislators passed laws to regulate and restrict the use of fish weirs, sometimes to preserve fish stocks, and sometimes to remove hazards to navigation (Godbold et al. 1994: 47). We have no positive evidence of the same from the Saxon period. Other possible factors include a catastrophic event or, more probably, change to the topography of the intertidal zone that undermined the effectiveness

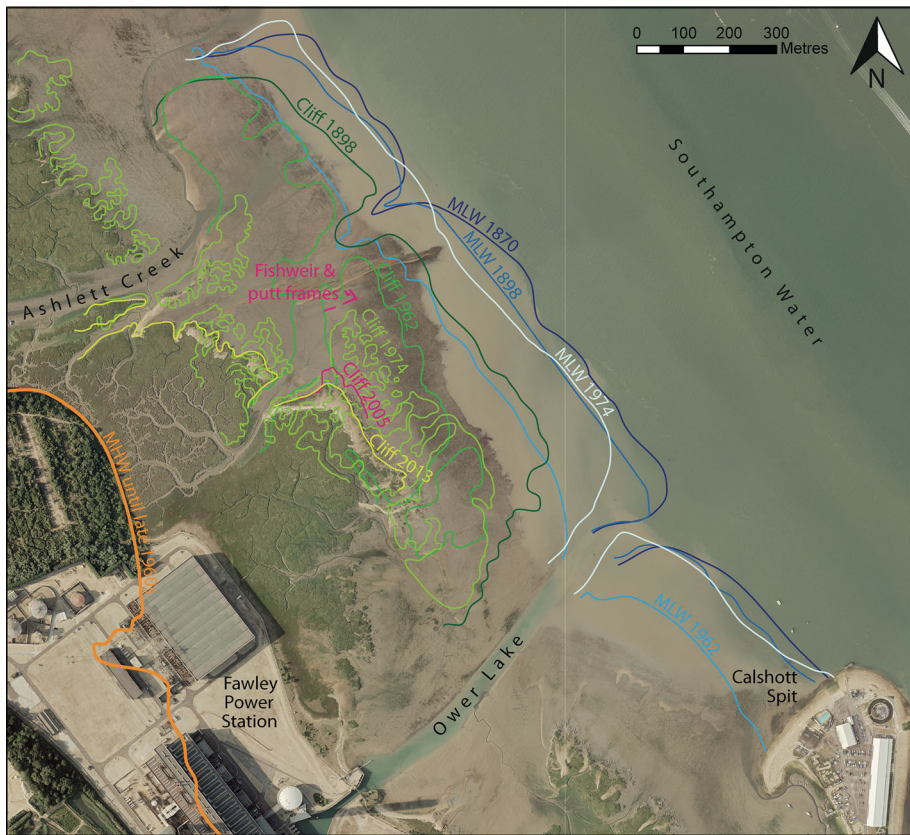
of the weir. Once abandoned, the parts of the weir above ground would have been subject to the destructive action of the sea, of rot, and of marine boring organisms.

## Saltmarsh Morphodynamics

The late first-millennium date of the Ashlett fish weir adds a useful datum for the understanding of the morphodynamics of the saltmarshes of this part of Southampton Water which, like many around Britain, are characterised by a marsh-edge cliff of 0.5–1 m in height, and below it a sloping ‘erosional shore platform’ that transitions to the mudflats below (Allen 1987, 1989, 2001, 2002; Kirkby 1990; Wilkinson and Murphy 1995; Allen and Gardiner 2000; Ke and Collins 2002). Juxtaposition of geo-referenced Ordnance Survey maps and remote sensing imagery of the area since 1898—together with surveys of the nearby saltmarsh cliff edge conducted by the authors in 2005 and 2016—demonstrate a marked and ongoing regression of the marsh edge (Fig. 11). A total saltmarsh edge retreat of 294 m in the area of the weir seen during that 118-year period corresponds to an average of  $2.5 \text{ m yr}^{-1}$ . However, some 187 m of that retreat has taken place since the survey for the 1962 Ordnance Survey 1:10,000 map was carried out. Hence the average rate over the last half-century has been some  $3.5 \text{ m yr}^{-1}$ . This figure compares with recent rates of  $1\text{--}3 \text{ m yr}^{-1}$  recorded in the nearby Hythe area (Quaresma et al. 2007), and  $4\text{--}5 \text{ m yr}^{-1}$  in the West Solent (Ke and Collins 2002: 422). What this dynamic also demonstrates is that the remains of the fish weir and traps were buried under saltmarsh until after the survey that was conducted for the 1962 Ordnance Survey map, but before that of the 1974 map, after which the structures became exposed as the saltmarsh plateau retreated and the now-exposed mud that covered them eroded away.

What the dating also indicates is that the marsh cannot have existed to its 1898 extent at the time the weir was functioning, in the late-first millennium AD. Indeed, operation of the weir would have required a significant area of open foreshore above it that would function as a catchment area. What this suggests is either that the saltmarshes of the area prograded significantly at some point following construction of the weir in the early medieval period until a turning point some time before 1898, or that that an inlet—presumably Ashlett Creek—cut through the marsh at point further north than the Creek currently does. Both may have played a role. However, the former interpretation corresponds with Pye and French’s conclusion (1993) that, in south-eastern England, saltmarshes prograded between ‘the Middle Ages’ and the nineteenth century, having previously been in a phase of retreat from about AD 200.

Caution should be exercised in considering the implications of this dating, however. While it is tempting to imagine a single episode of progradation beginning some time after abandonment of the weir, followed by a single period of retreat, the situation may well have been more complex. Saltmarshes have been observed to undergo autocyclic phases of expansion, retreat and recovery governed by feedback mechanisms that connect marsh platform accretion, slope, wave action and cliff-face erosion (Yapp et al. 1917; Linthorst and Seneca 1980; Harmsworth and Long 1986; Pringle 1995; Pye 1995; Allen 2000a; 2000b; Ke and Collins 2002: 432–433; Van de Koppel et al. 2005; Pedersen and Bartholdy 2007; van der Wal et al. 2008). These may also be related to feedback cycles of vertical accretion, first proposed by Pethick (1981) and subsequently refined by van Wijnen and Bakker (2001), whereby rates of sediment accretion on a saltmarsh plateau diminish over a period of 100–200 years as the frequency of inundation of the accreting marsh diminishes.



**Fig. 11** Changes in the location of the mean low water mark (1870–1974) and saltmarsh cliff (1898–2013) in the area around the Ashlett fishery structures, georeferenced onto aerial photography. All mean low- and high-water marks and cliff lines are traced from the 1:10,560/1:10,000 Ordnance Survey maps of 1870, 1898, 1962 and 1974. The 2005 cliff-edge survey is by the authors. The 2013 cliff is traced from the base image. (Image: fishery structures survey by the authors; aerial photograph courtesy of Channel Coastal Observatory (Image ID: 404082; [www.channelcoast.org](http://www.channelcoast.org)); Ordnance Survey maps (Scale 1:10,560 and 1:10,000) from which high-water, low-water and cliff-edge lines derived Crown Copyright and Landmark Information Group Limited (2016). All rights reserved. (1870, 1898, 1962 and 1974)

Moreover, the planimetric development of the intertidal zone—particularly the relationship between the saltmarsh and downslope mudflats—also appears also to be cyclical, and connected to erosion of the saltmarsh cliff (Pethick 1981; Lewes 1997; Gabet 1998; Schwimmer 2001; Marani et al. 2007; Gedan et al. 2009). Indeed, Quaresma et al. (2007) have observed an inverse relationship between cliff retreat and mudflat accretion at nearby Hythe flats, just 6 km up the Southampton Water estuary from Ashlett. Moreover, the deposition of sediment from an eroding saltmarsh onto the mudflats below can lead to a new colonisation by pioneer saltmarsh flora seaward of the saltmarsh cliff (van der Wal et al. 2008: 361).

Notwithstanding these caveats, salt marshes have been observed to be in a state of retreat across many wetlands of northwest Europe—and beyond—in some cases since the nineteenth century (Penland et al. 1990; Allen 2000; van der Wal and Pye 2004). Effected estuaries include those of the Greater Thames since the nineteenth century (Harmsworth



and Long 1986; van der Wal and Pye 2004), parts of the Westerschelde (van der Wal et al. 2008), and Southampton Water and the Solent since the eighteenth century (Tubbs 1980; Hooke and Riley 1987; Western Solent and Southampton Water Coastal Group. 1998; May 2000). Several reasons for this retreat have been explored. One of them is the dieback of saltmarsh plants, particularly *Spartina anglica*, whether naturally or as a result of pollutants such as hydrocarbons or herbicides (Baker 1975; Manners 1975; Meakins et al. 1995; Leggett et al. 1995; Western Solent and Southampton Water Coastal Group. 1998; Mason et al. 2003). This process was first observed in the nearby Beaulieu estuary in 1928, and is widespread in southern England (Goodman et al. 1959; Haynes and Coulson 1982). Another reason is dredging: Cox et al. have demonstrated the impact of an increased tidal prism on erosion rates in the highly modified Westerschelde estuary on the Dutch–Belgian border as a result of channel dredging (Smit et al. 1997; Cox et al. 2003), while Blott et al. have shown how dredging and training-wall construction in Liverpool Bay and the Mersey’s Outer Estuary were “the most important factors affecting the morphology and distribution of sediment in the estuary in the last 100 years”, causing a net influx of sediment into the Inner Estuary (2006: 202).

Dredging is surely a significant factor in Southampton Water, where the shipping channel has been enlarged progressively since the nineteenth century AD in order to accommodate ever-larger ships. The process has continued into recent times, with major works taking place in 1970 (Flood 1981), the late 1990s (Morris and Gibson 2007) and, most recently, in 2013–14, when the main channel was both widened and deepened in a scheme that set out to remove 30mn t of material (Associated British Ports 2013). Dredging is active in increasing the erosion of mudflats (Cox et al. 2003; van der Wal and Pye 2004: 387), diminishing the supply of sediment to the saltmarsh plateau due to reduced periods of inundation (Pethick 1981; Van Wijnen and Bakker 2001), and increasing ebb flow rates (Dronkers 1986). Dyer (1970) observed linear furrows just below the mean low water mark in Southampton Water between Fawley and Calshott, close to the Ashlett fisheries, and attributed this to secondary currents set up by dredging of the main channel. A further factor in saltmarsh cliff retreat observed in Southampton Water is shell-induced erosion caused by the accumulation of shells along and on top of the salt-marsh edge (Quaresma et al. 2007). The expansion of shell cheniers or ‘washover fans’ (Ke and Collins 2002: 419) on the Ashlett saltmarsh edge was a notable change observed in the area between fieldwork done in 2005 and 2016, as was the extensive covering of previously exposed Holocene mudflats with significant quantities of shell debris. The deposition of shell material is reported to cause vegetation damage, with denuded marsh-edges then eroding faster than vegetated ones (Francalanci et al. 2013).

The significance of the role of wind-blown waves in saltmarsh erosion is not so clearly established—especially in a relatively sheltered estuary such as that of Southampton Water (Quaresma et al. 2007: 132). However high-amplitude ship and boat waves have been seen to be a factor in erosion processes in narrow channels (Anderson 1976; Parnell and Kofoed-Hansen 2001; Bauer et al. 2002; Verney et al. 2007; Herbich and Schiller 2011), and might be a factor in Southampton Water too. The role of ongoing sea-level rise in the retreat of the salt marshes is also unproven. Tide-gauge data for the nearest station, at Portsmouth, suggests a  $2 \text{ mm yr}^{-1}$  increase in local mean relative sea levels over the two decades to 2015,<sup>6</sup> while data for the century to 1996 suggests a rate of  $4\text{--}5 \text{ mm yr}^{-1}$  (Cundy and Croudace 1996: 465). Saltmarshes are seen to be able to cope with sea-level rise, and

<sup>6</sup> Based on the annualised mean of monthly means for the years 1995–2015. The data were supplied by the British Oceanographic Data Centre as part of the function of the National Tidal and Sea Level Facility,

indeed outstrip it, provided that sedimentary supply remains adequate (Haslett et al. 2001)—but dredging in Southampton Water may well mean that this vital latter condition is not being met.

The construction of “hard” sea defences on the landward side of the marshes has also been identified as adding to saltmarsh stress, and contributing to “coastal squeeze” whereby marshes are compressed between advancing sea levels and rigid engineering: the local *Shoreline Management Plan* for the Ashlett area recommends a “hold the existing defence line” policy (Western Solent and Southampton Water Coastal Group. 1998; Bray et al. 2000: 102). This process of squeeze has been exacerbated by saltmarsh reclamation activity as part of construction of the Fawley oil refinery and power station, both of which advanced the high water mark seaward—the former by as much as 700 m, and the latter by up to 300 m (Coughlan 1975: 28).

## Conclusion

Discovery of a middle-Saxon-period fish weir and (undated) fish traps in the intertidal zone near Ashlett provides a new insight into maritime resource exploitation in Southampton Water in the early medieval period. At a time when nearby Southampton was emerging as a prominent political centre, communities on the estuary were deploying standing fishery technologies capable of making large catches that might have found their way by boat to urban markets. The owners of the weir are of course not known, but historical records indicate that ecclesiastical ownership of weirs was common prior to the Reformation. The weir is the only one on the south coast of mainland Britain to have been studied in detail.<sup>7</sup> Its circular pound is similar to two other weirs of Saxon/Norman date on the nearby Isle of Wight, and suggests a local vernacular in fish weir technologies that is largely distinct from broadly contemporary examples in, for example, the Severn, Thames and Blackwater estuaries. Meanwhile, it bears striking resemblances to fish-weir technologies deployed on the southern shore of the English Channel until recent times.

The Saxon dating of the core fish weir provides a useful datum in understanding foreshore morphodynamics in this part of the Southampton Water estuary. Regressive mapping demonstrates that the local saltmarsh has been in a state of retreat since the late nineteenth century, and that the structure became uncovered between the time of the Ordnance Survey’s survey for its 1962 map, and that of 1974. However, the existence and location of the weir demonstrates that the saltmarsh in the late first millennium AD cannot have extended so far across the intertidal zone as it went on to do in the nineteenth century. Saltmarshes are known to fluctuate in their extent, and those of southern Britain are currently in a state of retreat. Given that the weir would have needed an open area above it in the intertidal zone into which fish could range before following the ebb tide into the trap, this suggests that the saltmarsh was also in a state of abeyance in the eighth–ninth centuries relative to its nineteenth century position which, given its proximity to the mean low tide level, must have been something of a maximum.

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Footnote 6 continued

hosted by the Proudman Oceanographic Laboratory and funded by the Environment Agency and the Natural Environment Research Council. See <http://www.bodc.ac.uk>. Last accessed 6 September 2016.

<sup>7</sup> Although Trevarthen (2010: 33) suggests that v-shaped features visible under water near Needs Ore Point in the western Solent on Royal Air Force aerial photography may be the traces of “medieval or post-medieval” fish weirs. These have not been ground-truthed.

The dynamic situation that led to the exposure of the Ashlett fish weir structures will continue to determine its fate. The inspection of 2016 revealed a site that was much changed since 2005. Few of the fish weir's posts—and none of those from the fish-trap frames or western extension—were visible above the surface. In part this was because a mobile layer of broken shell had become deposited over what was previously exposed blue–grey Holocene clay, covering the posts. But it is also probable that the some of the posts that were least embedded had been eroded out of the substrate after the 2005 fieldwork, particularly if erosion patterns observed at Hythe are also present here (Quaresma et al. 2007). In the absence of significant human intervention in broader estuary dynamics, the posts will remain subject to the tidal and sedimentary regimes at work in the intertidal zone—including cockle dredging activities suggested by drag marks on the substrate visible both during the 2016 visit and on remote sensing imagery of the area.

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### Compliance with Ethical Standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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## References

- Al-Abdulrazzak D, Pauly D (2013) Managing fisheries from space: Google Earth improves estimates of distant fish catches. *ICES J Mar Sci J du Cons* 71:450–454. doi:[10.1093/icesjms/fst178](https://doi.org/10.1093/icesjms/fst178)
- Alexander AB (1902) Notes on the boats, apparatus and fishing methods employed by the natives of the South Sea Islands, etc. *Rep Comm Fish* 27:741–829
- Allen JRL (1987) Late Flandrian shoreline oscillations in the Severn Estuary: the Rumney formation and its typesite (Cardiff area). *Philos Trans R Soc B315*:157–174
- Allen JRL (1989) Evolution of salt-marsh cliffs in muddy and sandy systems: a qualitative comparison of British west-coast estuaries. *Earth Surf Process Landforms* 14:85–92
- Allen JRL (2000) Morphodynamics of Holocene salt marshes: a review sketch from the Atlantic and Southern North Sea coasts of Europe. *Quat Sci Rev* 19:1155–1231
- Allen JRL (2001) Late quaternary stratigraphy in the Gwent levels (southeast Wales): the subsurface evidence. *Proc Geol Assoc* 112:289–315. doi:[10.1016/S0016-7878\(01\)80010-9](https://doi.org/10.1016/S0016-7878(01)80010-9)
- Allen JRL (2002) Retreat rates of soft-sediment cliffs: the contribution from dated fishweirs and traps on Holocene coastal outcrops. *Proc Geol Assoc* 113:1–8. doi:[10.1016/S0016-7878\(02\)80001-3](https://doi.org/10.1016/S0016-7878(02)80001-3)
- Allen JRL (2004) Fishtraps in the middle Severn Estuary: air-photographic evidence from the mid-twentieth century. *Archaeol Sev Estuary* 15:31–48

- Allen J, Bell M (1999) A late Holocene tidal paleochannel, Redwick, Gwent: late Roman activity and a possible early medieval fish trap. *Archaeol Sev Estuary* 10:53–64
- Allen MJ, Gardiner J (2000) Our changing coast: a survey of the intertidal archaeology of Langstone Harbour, Hampshire. Council for British Archaeology, York
- Allen LG, Gibbard PL (1993) Pleistocene evolution of the Solent River of southern England. *Quat Sci Rev* 12:503–528
- Allen JRL, Haslett SK (2006) A wooden fishtrap in the Severn Estuary at Northwick Oaze, South Gloucestershire. *Archaeol Sev Estuary* 17:169–173
- Allen JR, Rippon SJ (1997) Iron age to early modern activity and palaeochannels at Magor Pill, Gwent: an exercise in lowland coastal-zone geoarchaeology. *Antiq J* 77:327–370
- Anderson FE (1976) Rapid settling rates observed in sediments resuspended by boat waves over a tidal flat, Netherlands. *J Sea Res* 10:44–58
- Antipa G (1916) Pescăria si Pescuitul in România. Academia Română, Bucharest
- Antoine P, Coutard J-P, Gibbard P et al (2003) The Pleistocene rivers of the English Channel region. *J Quat Sci* 18:227–243. doi:10.1002/jqs.762
- Associated British Ports (2013) ABP receives consent for Southampton approach channel dredge. <http://www.abports.co.uk/newsarticle/40/>. Accessed 2 Apr 2017
- Aston M, Dennison E (1988) Fishponds in Somerset. In: Aston M (ed) Medieval fish, fisheries and fishponds in England. British Archaeological Reports, Oxford, pp 391–408
- Avery G (1975) Discussion on the age and use of tidal fish-traps (visvuyers). *South Afr Archaeol Bull* 30:105–113
- Baker JM (1975) The effects of oil pollution on *Spartina Anglica*. In: Stranack F, Coughlan J (eds) *Spartina in the solent: de Rothschild Symposium*, Exbury, Hampshire, June 1975. Solent Protection Society, Exbury, pp 22–23
- Bannerman N, Jones C (1999) Fish-trap types: a component of the maritime cultural landscape. *Int J Naut Archaeol* 28:70–84
- Bathgate TD (1949) Ancient fish-traps or yairs in Scotland. *Proc Soc Antiqu Scotl* 83:98–102
- Bauer BO, Lorang MS, Sherman DJ (2002) Investigating boat-wake-induced levee erosion using sediment suspension measurements. *J Waterw Port Coast Ocean Eng* 128:152–162
- Bell M, Caseldine A, Neumann H (2000) Prehistoric intertidal archaeology in the Welsh Severn Estuary: CBA Research Report 120. Council for British Archaeology, York
- Billard C (ed) (2012) *Terre de pêcheries: 4000 ans d'archéologie et d'histoire sur le littoral de la Manche*. Centre Régional de Culture Ethnologique et Technique, Caen
- Billard C (2016a) Les Sources. In: C Billard and V Bernard (eds) *Pêcheries de Normandie: archéologie et histoire des pêcheries littorales de Département de la Manche*, Rennes, pp 19–31
- Billard C (2016b) Traditions techniques de pêcheries du Golfe Normand-Breton dans le contexte du littoral français (du XVIII<sup>e</sup> à aujourd'hui). In: Billard C, Bernard V (eds) *Pêcheries de Normandie: archéologie et histoire des pêcheries littorales de Département de la Manche*, Rennes, pp 91–107
- Billard C, Bernard V (eds) (2016) *Pêcheries de Normandie: archéologie et histoire des pêcheries littorales de Département de la Manche*, Rennes
- Billard C, Bernard V, Bouffignay A et al (2012a) Les Pêcheries Préhistoriques. In: Billard C (ed) *Terre de pêcheries: 4000 ans d'archéologie et d'histoire sur le littoral de la Manche*. Centre Régional de Culture Ethnologique et Technique, Caen, pp 38–49
- Billard C, Chatelais L, Coccagn J-Y, Gallet J (2012b) Techniques Traditionnelles des Pêcheries gu Golfe Normand-Breton. In: Billard C (ed) *Terre de pêcheries: 4000 ans d'archéologie et d'histoire sur le littoral de la Manche*. Centre Régional de Culture Ethnologique et Technique, Caen, pp 82–99
- Billard C, Bernard V, Bouffignay A et al (2013) Techniques et modes d'exploitation des pêcheries sur le littoral Normand (France): Un essai de bilan de dix années de travaux archéologiques. In: Daire M, Dupont C, Baudry A, et al (eds) *Ancient Maritime Communities and the Relationship between People and Environment along the European Atlantic Coasts/Anciens peuplements littoraux et relations Home/Milieu sur les côtes de l'Europe atlantique*. Proceedings of the HOMER 2011 Conference, Va. Archaeopress, Oxford, pp 139–150
- Blott SJ, Pye K, Van der Wal D, Neal A (2006) Long-term morphological change and its causes in the Mersey Estuary, England. *Geomorphology* 81:185–206
- Bowen G (1998) Towards a generic technique for dating stone fish traps and weirs. *Aust Archaeol* 47:39–43
- Bray MJ, Hooke JM, Carter D (2000) Sea-level rise in the Solent region. In: Collins M, Ansell K (eds) *Solent science: a review*. Elsevier, Amsterdam, pp 101–102
- Brennand M, Taylor M (2003) The survey and excavation of a bronze age timber circle at holme-next-the-sea, Norfolk, 1998–9. *Proc Prehist Soc* 69:1–84

- Brown A, Bell M, Timpany S, Nayling N (2005) Mesolithic to neolithic and medieval coastal environmental change: intertidal survey at Woolaston, Gloucestershire. *Archaeol Sev Estuary* 16:67–83
- Brown A, Morgan R, Turner R, Pearson C (2007) Fishing structures on the Sudbrook Foreshore, Monmouthshire, Severn Estuary. *Archaeol Sev Estuary* 18:1–17
- Brunning R (2007) A Millenium (sic.) of fishing structures in Stert Flats, Bridgewater Bay, Inner Bristol Channel. *Archaeol Sev Estuary* 18:67–83
- Burges D (2000) Ornithology of the Solent. In: Collins M, Ansell K (eds) *Solent science: a review*. Elsevier, Amsterdam, pp 261–270
- Byram S (1998) Fishing weirs in Oregon Coast estuaries. Hidden dimensions: the cultural significance of Wetland Archaeology. University of British Colombia Press, Vancouver, pp 199–219
- Caldwel ME (2008) A view from the shore: interpreting fish trap use in Comox Harbour through Zooarchaeological Analysis of fish remains from the Q'umu'xs Village Site (DkSf-19), Comox Harbour, British Colombia. University of Manitoba, Winnipeg
- Carter R, Killick R (2010) Al-Khor Island: investigating coastal exploitation in bronze age Qatar. Moonrise Press, Ludlow
- Catchpole T, Brunning R, Chadwick A (2013) Casting the net wider: further dating and discussion of fish traps recorded by the Severn Estuary Rapid Coastal Assessment Survey. *Archaeol Sev Estuary* 22:1–22
- Chadwick AM, Catchpole T (2012) Casting the net wide: mapping and dating fish traps in the Severn Estuary through the Severn Estuary Rapid Coastal Zone assessment survey (RCZAS). *Archaeol Sev Estuary* 21:47–80
- Chatelais L, Cahierre A, Billard C (2012) Portraits des Pêcheries. In: *Terre de pêcheries: 4000 ans d'archéologie et d'histoire sur le littoral de la Manche*. Centre Régional de Culture Ethnologique et Technique, Caen, pp 108–121
- Chen TP (1976) *Aquaculture practices in Taiwan*. Fishing News Books, Farnham
- Cobb JN (1901) Commercial fisheries of the Hawaiian Islands. *Rep Comm Fish* 27:383–499
- Cohen N (2003) Boundaries and settlement: the role of the River Thames in boundaries in Early Medieval Britain. *Stud Anglo Saxon Hist Archaeol* 12:9–20
- Cohen N (2008a) Middle Saxon fish traps: Chelsea 1 (Middlesex). In: Cowie R, Blackmore L (eds) *Early and Middle Saxon rural settlement in the London region*. Museum of London Archaeological Service, London, pp 119–121
- Cohen N (2008b) Middle Saxon fish traps: Chelsea 2 (Middlesex). *Early and Middle Saxon rural settlement in the London region*. Museum of London Archaeological Service, London, pp 121–122
- Cohen N (2008c) Middle Saxon fish traps: Isleworth (Middlesex). In: Cowie R, Blackmore L (eds) *Early and Middle Saxon rural settlement in the London region*. Museum of London Archaeological Service, London, pp 123–124
- Cohen N (2011) Early Anglo-Saxon fish traps on the River Thames. In: Brookes S, Harrington S, Reynolds A (eds) *Studies in early Anglo-Saxon art and archaeology: papers in honour of Martin G. Welch*. Archaeopress, Oxford, pp 131–138
- Connaway JM (2007) Fishweirs: a world perspective with emphasis on the fish-weirs of Mississippi. *Archaeological Report No. 33*. Jackson, Mississippi
- Cox R, Wadsworth R, Thomson A (2003) Long-term changes in salt marsh extent affected by channel deepening in a modified estuary. *Cont Shelf Res* 23:1833–1846. doi:10.1016/j.csr.2003.08.002
- Cressey M, Hale AGC (1998) *Coastal Assessment Survey Inner Moray Firth*. Edinburgh
- Crowther S, Dickson A (2008) Severn estuary: rapid coastal zone assessment. National mapping programme, Gloucester
- Cundy AB, Croudace IW (1996) Sediment accretion and recent sea-level rise in the Solent, Southern England: inferences from radiometric and geochemical studies. *Estuar Coast Shelf Sci* 43:449–467. doi:10.1006/ecss.1996.0081
- Daly A (2014) Fine-tuned chronology of medieval fishweirs in the Fergus Estuary, Co., Clare, Ireland. *J Wetl Archaeol* 14:6–21. doi:10.1179/1473297114Z.0000000006
- Dargin P (1976) *Aboriginal fisheries of the Darling–Barwon Rivers*. Brewarrina Historical Society, Dubbo
- Davis FM (1958) *An account of the fishing gear of England and Wales*. Her Majesty's Stationery Office, London
- Dawson T (2004) *Locating fish-traps on the Firth of Forth and the Moray Firth*
- Dennison E (1985) Minehead fishweirs. *Somerset Archaeol Nat Hist* 129:20–22
- Desse-Berset N, Billard C (2012) Introduction. In: Billard C (ed) *Terre de pêcheries: 4000 ans d'archéologie et d'histoire sur le littoral de la Manche*. Centre Régional de Culture Ethnologique et Technique, Caen, pp 9–17
- Dillon M, O'Sullivan A (2008) *Medieval Fishweirs on the Fergus Estuary, Co. Clare*. Project Report to the Heritage Council. Dublin

- Dronkers J (1986) Tidal asymmetry and estuarine morphology. *Neth J Sea Res* 20:117–131
- Duhamel du Monceau H-L (1769) *Traité général des pesches: et histoire des poissons qu'elles fournissent tant pour la subsistance des hommes que pour plusieurs autres usages qui ont rapport aux arts et au commerce*. Académie Royale des Sciences, Paris
- Dyer KR (1970) Linear erosional furrows in Southampton Water. *Nature* 225:56–58
- Dyer KR (1980) Sedimentation and sediment transport. In: Council NER (ed) *The Solent Estuarine System: An Assessment of Present Knowledge*. Natural Environment Research Council, Swindon, pp 20–24
- Dyer C (1988) The consumption of fresh-water fish in medieval England. In: Aston M (ed) *Medieval fish, fisheries and fishponds in England*. British Archaeological Reports, Oxford, pp 27–38
- Everard CE (1954) The Solent river: a geomorphological study. *Trans Pap Inst Br Geogr* 20:41–58
- Everett L (2007) Targeted inter-tidal survey. Suffolk County Council, Ipswich
- Flood RD (1981) Distribution, morphology, and origin of sedimentary furrows in cohesive sediments, Southampton Water. *Sedimentology* 28:511–529. doi:[10.1111/j.1365-3091.1981.tb01699.x](https://doi.org/10.1111/j.1365-3091.1981.tb01699.x)
- Francalanci S, Bondoni M, Rinaldi M, Solari L (2013) Ecomorphodynamic evolution of salt marshes: experimental observations of bank retreat processes. *Geomorphology* 195:53–65
- Gabet EJ (1998) Lateral migration and bankerosion in a saltmarsh tidal channel in San Francisco Bay, California. *Estuaries* 21:745–753
- Gabriel O, Lange K, Dahm E, Wendt T (2005) *Fish catching methods of the world*, fourth. Blackwell Publishing Ltd, Oxford
- Gedan KB, Silliman BR, Bertness MD (2009) Centuries of human-driven change in salt marsh ecosystems
- Gilman PJ (1998) Essex fishtraps and fisheries: an integrated approach to survey, recording and management. In: Bernick K (ed) *Hidden dimensions: the cultural significance of wetland archaeology*. UBC Press, Vancouver, pp 273–289
- Godbold S, Turner RC, Hillam J et al (1994) Medieval fishtraps in the Severn Estuary. *Mediev Archaeol* 38:19–54. doi:[10.1080/00766097.1994.11735565](https://doi.org/10.1080/00766097.1994.11735565)
- Goodman P, Braybrooks E, Lambert J (1959) Investigations into “dieback” in *Spartina townsendii* in Britain. *J Ecol* 47:651–677
- Greenwood P (2008) Early Saxon FISH TRAPS: Putney (Surrey). In: Cowie R, Blackmore L (eds) *Early and Middle Saxon rural settlement in the London region*. Museum of London Archaeological Service, London, pp 116–118
- Gribble J (2005) The ocean baskets: pre-colonial fish traps on the Cape South Coast. *Digging Stick* 22:1–4
- Hale (1998) Dingwall fish trap survey and sampling project
- Hale AGC (2005) Fish-traps in Scotland: construction, supply, demand and destruction. In: Klapste J (ed) *Water management in medieval rural economy*. Institute of Archaeology, Academy of Sciences of the Czech Republic, Prague, pp 119–126
- Hall RL, Clark CP (2000) A Saxon inter-tidal timber fish weir at Collins Creek in the Blackwater estuary. *Essex Archaeol Hist* 31:125–146
- Harmsworth GC, Long SP (1986) An assessment of saltmarsh erosion in Essex, England, with reference to the Dengie Peninsula. *Biol Conserv* 35:377–387
- Haslett SK, Strawbridge F, Martin NA, Davies CFC (2001) Vertical saltmarsh accretion and its relationship to sea-level in the Severn estuary, U.K.: an investigation using foraminifera as tidal indicators. *Estuar Coast Shelf Sci* 52:143–153
- Haynes F, Coulson M (1982) The decline of *Spartina* in Langstone Harbour, Hampshire. *Proc Hampsh F Club Archaeol Soc* 38:5–18
- Hegarty C, Knight S, Sims R (2014) Rapid coastal zone assessment survey national mapping programme for South West England—south coast Devon: component One: National Mapping Programme. Bradninch
- Heppell EM (2011) Saxon fishtraps in the Blackwater Estuary, Essex: monitoring survey at Collins Creek, Pewet Island and the Nass, 2003–2007. *Essex Archaeol Hist (Fourth Series)* 2:76–97
- Herbich J, Schiller R (2011) Surges and waves generated by ships in a constricted channel. *Coast Eng Proc* 1:3213–3226
- Hildich M (1998) Preliminary Survey of Coastal Archaeology Including the Intertidal Zone between Wains Hill (Clevedon) and Sand Point (Worle), North Somerset. *Archaeol Sev Estuary* 8:99–1–99–2
- Hodson F, West I (1972) Holocene deposits of Fawley, Hampshire, and the development of Southampton Water. *Proc Geol Assoc* 83:421–442
- Hooke J, Riley R (1987) *Historical changes on the Hampshire Coast 1870–1965*. Portsmouth Polytechnic Publications, Portsmouth
- Hooper J (2001) Ardersier: excavation of a possible fish trap. Historic Scotland and Highland Council Archaeology Unit, Inverness (Unpublished Report)
- Ingle C, Saunders H (2011) Aerial archaeology in Essex: the role of the national mapping programme in interpreting the landscape, vol 136. East Anglian Archaeol, Oxford



- James H (1996) Coastal assessment survey: the firth of forth from Dunbar to Border of Fife: GUARD archive report for Historic Scotland. Edinburgh
- James H, James T (2003) Fish Weirs on the Taf, Towy and Gwendraeth Estuaries, Camarthenshire. *Camarthensh Antiq* 39:22–48
- Jankó J (1900) *Herkunft der Magyarischen Fischerei*. Budapest
- Jecock M (2011) River fisheries and coastal Fish Weirs. English Heritage, Swindon
- Jeffrey B, Pitmag W (eds) (2010) The aech of Yap: a survey of sites and their histories. Yap State Historic Preservation Office, Yap
- Jeffrey B (2013) Reviving community spirit: furthering the sustainable, historical and economic role of fish weirs and traps. *J Marit Archaeol* 8:29–57
- Jenkins JG (1974) Fish weirs and traps. *Folk Life* 12:5–19
- Jenkins JG (1975) Nets and Coracles. David & Charles, Newton Abbot
- Joint Nature Conservation Committee (2001) SPA description: Solent and Southampton Water. <http://jncc.defra.gov.uk/default.aspx?page=2037>
- Jones C (1983) Walls in the sea—the groudau of Menai Some: marine antiquities of the Menai Straits. *Int J Naut Archaeol* 12:27–40. doi:[10.1111/j.1095-9270.1983.tb00109.x](https://doi.org/10.1111/j.1095-9270.1983.tb00109.x)
- Ke X, Collins M (2002) Saltmarshes in the West Solent (southern England): their morphodynamics and evolution. In: Healy T, Wang Y, Healy J-A (eds) *Muddy coasts of the world: processes, deposits and function*. Elsevier, Amsterdam, pp 411–440
- Kelly D (2014) *Archaeology of Aboriginal Fish traps in the Murray–Darling Basin*, Australia. Charles Sturt University, Sydney
- Kirkby R (1990) The sediment budget of the erosional zone of the Medway Estuary, Kent. *Proc Geol Assoc* 101:63–77
- Lambeck K (1993) Glacial rebound of the British Isles-II. A high-resolution, high-precision model. *Geophys J Int* 115:960–990
- Langouët L, Daire M-Y (2009) Ancient maritime fish-traps of Brittany (France): a reappraisal of the relationship between human and coastal environment during the holocene. *J Marit Archaeol* 4:131–148. doi:[10.1007/s11457-009-9053-2](https://doi.org/10.1007/s11457-009-9053-2)
- Legendre R (1912) Le Pêche chez les Peuples Primitifs. *Bull Institut Océanographique Monaco* 9:19–47
- Leggett D, Bubb JM, Lester JN (1995) The role of pollutants and sedimentary processes in flood defence. A case study: salt Marshes of the Essex Coast. UK. *Environ Technol* 16:457–466. doi:[10.1080/09593331608616286](https://doi.org/10.1080/09593331608616286)
- Lewes E (1924) The goredi near Llandewi Aberarth, Cardiganshire. *Archaeol Cambrensis* 74:397–400
- Lewes JT (1997) The record of deposition and the migration of elements in salt marshes. University of Southampton, Southampton
- Linthurst RA, Seneca ED (1980) Dieback of salt-water cordgrass (*spartina alterniflora* Loisel.) in the lower Cape Fear estuary of North Carolina: an experimental approach to re-establishment. *Environ Conserv* 7:59–66
- Loader R (2008) Isle of Wight Coastal Enhancement (Project 4842). Ryde
- Loader R, Westmore I, Tomalin D (1997) Time and Tide: an archaeological survey of the Wootton-Quarr coast. Isle of Wight Council, Isle of Wight
- Losco-Bradley PM, Salisbury CR (1988) A Saxon and Norman Fish Weir at Colwick, Nottinghamshire. In: Aston M (ed) *Medieval Fish, Fisheries and Fishponds in England*. British Archaeological Reports, Oxford, pp 329–351
- Louwe Kooijmans LP (1987) Neolithic settlement and subsistence in the wetlands of the Rhine/Meuse Delta of the Netherlands. In: Coles JM, Lawson AJ (eds) *European Wetlands in Prehistory*. Oxford University Press, Oxford, pp 227–251
- MacLaren PJR (1958) The fishing devices of central and southern Africa. Rhodes-Livingstone Museum, Livingstone
- Manners J (1975) Die-back of *spartina* in the Solent. In: Stranack F, Coughlan J (eds) *Rothschild symposium: spartina in the Solent*. Solent Protection Society, Exbury, pp 7–10
- Marani M, D'Alpaos A, Lanzoni S et al (2007) Understanding and predicting wave erosion of marsh edges. *Geophys Res Lett* 34. doi:[10.1029/2011GL048995](https://doi.org/10.1029/2011GL048995)
- Martin P (2008) The silent shores speak: Maritime Landscapes in North Argyll. *Hist Argyll* 13:10–17
- Mason C, Underwood GJ, Baker N et al (2003) The role of herbicides in the erosion of salt marshes in eastern England. *Environ Pollut* 122:41–49. doi:[10.1016/S0269-7491\(02\)00284-1](https://doi.org/10.1016/S0269-7491(02)00284-1)
- May S (2000) Saltmarsh monitoring studies adjacent to Fawley refinery. In: Collins M, Ansell K (eds) *Solent science: a review*. Elsevier, Amsterdam, pp 303–305
- McDonnell R (1980) Tidal fish weirs, West Somerset. *Somerset Archaeol Nat Hist* 124:134

- McErlean T, O'Sullivan A (2002) Foreshore tidal fish traps. In: McErlean T, McConkey R, Forsythe W (eds) Strangford Loch: an archaeological survey of the maritime cultural landscape. The Blackstaff Press, Belfast, pp 144–185
- McGrail S (1983) The interpretation of archaeological evidence for maritime structures. In: Annis PGW (ed) Sea studies. National Maritime Museum, Greenwich, pp 33–46
- McNiven IJ, Crouch J, Richards T et al (2012) Dating Aboriginal stone-walled fishtraps at Lake Condah, southeast Australia. *J Archaeol Sci* 39:268–286
- Meakins NC, Bubb JM, Lester JN (1995) The mobility, partitioning and degradation of atrazine and simazine in the salt marsh environment. *Mar Pollut Bull* 30:812–819. doi:[10.1016/0025-326X\(95\)00074-W](https://doi.org/10.1016/0025-326X(95)00074-W)
- Mitchell NC (1965) The lower bann fisheries. *Ulst Folklife* 11:1–32
- McQuade M, O'Donnell L (2007) Late Mesolithic fish traps from the Liffey estuary, Dublin, Ireland. *Antiquity* 81:569–584
- Mollat, M (1967) Le seigneurie maritime du Mont-Saint-Michel. In: R Foreville (ed) Millénaire monastique du Mont Saint Michel, vol 2: Vie montoise et rayonnement intellectuel, Paris, pp. 73–88
- Momber C (1991) Gorad Beuno: investigation of an ancient fish-trap in Caernarfon Bay, N. Wales. *Int J Naut Archaeol* 20:95–109. doi:[10.1111/j.1095-9270.1991.tb00304.x](https://doi.org/10.1111/j.1095-9270.1991.tb00304.x)
- Montgomery P, Forsythe W, Breen C (2015) Intertidal fish traps from Ireland: some recent discoveries in Lough Swilly, Co. Donegal. *J Marit Archaeol* 10:117–139. doi:[10.1007/s11457-015-9146-z](https://doi.org/10.1007/s11457-015-9146-z)
- Moore-Scott T (1993) Medieval fish weirs on the mid-tidal reaches of the Severn River (Ashleworth-Arlingham). *Glevensis* 27:4–6
- Morris RKA, Gibson C (2007) Port development and nature conservation—Experiences in England between 1994 and 2005. *Ocean Coast Manag* 50:443–462. doi:[10.1016/j.ocecoaman.2006.08.013](https://doi.org/10.1016/j.ocecoaman.2006.08.013)
- Morton AD, Davies S, Gieve S et al (1992) Excavations at Hamwic: volume 1. Council for British Archaeology, London
- Natural England (1994) Hythe to Calshot Marshes SSSI: Site of Special Scientific Interest (SSSI) Notified under Section 28 of the Wildlife and Countryside Act 1981
- Nayling N (1996) Further fieldwork and post-excavation: Magor Pill, Gwent Levels Intertidal Zone. *Archaeol Sev Estuary* 7:85–93
- Nayling N (1999a) Archaeology in the Severn Estuary. *Archaeol Sev Estuary* 10:99–113
- Nayling N (1999b) Medieval and later fish weirs at Magor Pill, Gwent Levels: coastal change and technological development. *Archaeol Sev Estuary* 10:99–113
- Nayling N (1999c) A stone and wattle fish weir complex in Swansea Bay. *Archaeol Sev Estuary* 10:115–124
- Nishimura A (1975) Cultural and social change in the modes of ownership of stone tidal weirs. In: Casteel EH, Quimby GJ (eds) Maritime adaptations of the Pacific. Mouton, The Hague, pp 77–88
- O'Sullivan A (1994) An early historic period fishweir on the Fergus Estuary, Co. Clare. *North Munst Antiq J* 35:52–61
- O'Sullivan A (1995) Medieval fishweirs on the Deel Estuary, Co. Limerick. *Archaeol Irel* 92:15–17
- O'Sullivan A (1997) Medieval fishtraps at Bunratty, Co. Clare. *The Other Clare* 21:40–42
- O'Sullivan A (2001) Foragers, Farmers and fishers in a Coastal Landscape. Royal Irish Academy, Dublin
- O'Sullivan A (2003) Place, memory and identity among estuarine fishing communities: interpreting the archaeology of early medieval fish weirs. *World Archaeol* 35:449–468. doi:[10.1080/0043824042000185810](https://doi.org/10.1080/0043824042000185810)
- O'Sullivan A (2005) Medieval Fish Traps on the Shannon Estuary, Ireland: interpreting people, place and identity in Estuarine Landscapes. *J Wetl Archaeol* 5:65–77
- O'Sullivan A, Daly A (1999) Prehistoric and medieval coastal settlement and wetland exploitation in the Shannon estuary, Ireland. In: Coles B, Coles J, Schou Jørgensen M (eds) Bog bodies, sacred sites and wetland archaeology. Wetland archaeology research project. Department of Archaeology, University of Exeter, Exeter, pp 177–184
- O'Sullivan A, Van de Noort R (2005) Temporality, cultural biography and seasonality: rethinking time in wetland archaeology. In: Barber J, Clark C, Cressey M, et al. (eds) Archaeology from the wetlands: recent perspectives. Proceedings of the 11th WARP conference. Edinburgh 2005. Society of Antiquaries of Scotland, Edinburgh, pp 67–77
- O'Sullivan A, McErlean T, McConkey R, McCooley P (1997) Medieval fishtraps in Strangford Loch, Co. Down. *Archaeol Irel* 11:36–38
- Paddenberg D, Hession B (2008) Underwater archaeology on foot: a systematic rapid foreshore survey on the North Kent Coast, England. *Int J Naut Archaeol* 37:142–152
- Page N (1996a) Kidwelly and Pembrey marshes: archaeological assessment of a wetland landscape. Archaeolog Dyfed Archaeological Trust, Llandeilo (Unpublished Report)

- Page N (1996b) Carmarthen Bay coastal wetlands survey, Phase 2. Archaeoleg Dyfed Archaeological Trust, Llandeilo (Unpublished Report)
- Page N (1997) Llanalli and Loughor Wetlands: an archaeological assessment of the northern shore of the Burry Inlet and the lower reaches of the Loughor Estuary. Archaeoleg Dyfed Archaeological Trust, Llandeilo (Unpublished Report)
- Pannett DJ (1988) Fish weirs of the River Severn with particular reference to Shropshire. In: Aston M (ed) *Medieval fish, fisheries and fishponds in England*. Br Archaeol Rep, Oxford, pp 371–389
- Parnell KE, Kofoed-Hansen H (2001) Wakes from large high-speed ferries in confined coastal waters: management approaches with examples from New Zealand and Denmark. *Coast Manag* 29:217–237. doi:[10.1080/08920750152102044](https://doi.org/10.1080/08920750152102044)
- Pedersen JBT, Bartholdy J (2007) Exposed salt marsh morphodynamics: an example from the Danish Wadden Sea. *Geomorphology* 90:115–125. doi:[10.1016/j.geomorph.2007.01.012](https://doi.org/10.1016/j.geomorph.2007.01.012)
- Pederson L (1995) 7000 years of fishing: stationery fishing structures in the Mesolithic and afterwards. In: Fischer A (ed) *Man and the Sea in the Mesolithic: coastal settlement above and below Present Sea Level*. Oxbow, Oxford
- Peltier WR, Shennan I, Drummond R, Horton B (2002) On the postglacial isostatic adjustment of the British Isles and the shallow viscoelastic structure of the Earth. *Geophys J Int* 148:443–475. doi:[10.1046/j.1365-246x.2002.01586.x](https://doi.org/10.1046/j.1365-246x.2002.01586.x)
- Penland S, Roberts HH, Williams SJ et al (1990) Coastal land loss in Louisiana. *Trans Coast Assoc Geol Sci* 90:685–699
- Pethick JS (1981) Long-term accretion rates on tidal salt marshes. *J Sediment Petrol* 51:571–577
- Pink F (2016) Rapid coastal zone assessment survey for South West England–South Devon coast: results of Phase 1, Component 2: Desk-based assessment. AC Archaeology, Bradninch (Unpublished Report)
- Preece C (2005) A conflict of interests: the fish traps of the Taw and Torridge estuaries. *Proc Devon Archaeol Soc* 63:139–165
- Pringle AW (1995) Erosion of a cyclical saltmarsh in Morecombe Bay, north–west England. *Earth Surf Process Landf* 20:387–405
- Pye K (1995) Controls on long-term marsh accretion and erosion in The Wash, Eastern England. *J Coast Res* 11:337–356
- Quaresma VDS, Bastos AC, Amos CL (2007) Sedimentary processes over an intertidal flat: a field investigation at Hythe flats, Southampton Water (UK). *Mar Geol* 241:117–136
- Reimer P, Bard E, Warren Beck J et al (2013) IntCal13 and Marine13 radiocarbon age calibration curves 0–50,000 years cal BP. *Radiocarbon* 55:1869–1887
- Ribeiro CHA, Wanick JJ, Sharples J (2004) Observations of the spring–neap modulation of the gravitational circulation in a partially mixed estuary. *Ocean Dyn* 54:299–306
- Rippon S (2004) Making the most of a bad situation? Glastonbury Abbey, Meare, and the medieval exploitation of wetland resources in the Somerset Levels. *Mediev Archaeol* 48:91–130
- Robertson P (1996) Coastal assessment survey for historic Scotland: Fife–Kincardine to Fife Ness. Maritime Fife (Unpublished Report)
- Robertson D, Ames J (2010) Early medieval intertidal fishweirs at Holme Beach, Norfolk. *Mediev Archaeol* 54:329–346
- Rowbotham F (1993) The fish weirs of the River Severn. *Glevensis* 27:4–6
- Russel A (2002) Anglo-Saxon. The Millennium Publication: a review of archaeology in Hampshire 1980–2000. Hampshire Field Club and Archaeological Society, Hampshire, pp 20–26
- Salisbury CR (1981) An Anglo-Saxon fish weir at Colwick, Nottinghamshire. *Trans Thorot Soc Nottinghamsh* 85:26–36
- Salisbury CR (1991) Primitive British fishweirs. In: Good GL, Jones RH, Ponsford MW (eds) *Waterfront Archaeology: Proceedings of the Third International Conference, 1988*. Council for British Archaeology, London, pp 76–79
- Sands R, O’Sullivan A, Daly A, Dillon M (2016) Old maps, channel change, serendipity and loss: medieval fishweirs on the Fergus Estuary, Co., Clare, Ireland. *J Wetl Archaeol* 16:17–32. doi:[10.1080/14732971.2016.1223809](https://doi.org/10.1080/14732971.2016.1223809)
- Scarce C (2009) European fisheries history: pre-industrial origins of overfishing. ProQuest Discovery Guides. <http://www.csa.com/discoveryguides/fish/review.pdf>. Accessed 2 Apr 2017
- Schwimmer RA (2001) Rates and processes of marsh shoreline erosion in Rehobot Bay, Delaware, U.S.A. *J Coast Res* 17:672–683
- Senogles D (1969) The story of Yns Gorad Goch in the Menai Straits. Published by the Author, Isgraig
- Sergeant RB (1968) Fisher-folk and fish-traps in al-Bahrain. *Bull Sch Orient Afr Stud Univ London* 31:486–514

- Sharples J (2000) Water circulation in Southampton Water and the Solent. In: Collins MB, Ansell K (eds) Solent science—a review. Proceedings of Solent Science Conference, Southampton, 29 September 2000. Elsevier Science, Amsterdam, pp 45–53
- Shennan I, Horton B (2002) Holocene land- and sea-level changes in Great Britain. *J Quat Sci* 17:511–526. doi:[10.1002/jqs.710](https://doi.org/10.1002/jqs.710)
- Shennan I, Bradley S, Milne G et al (2006) Relative sea-level changes, glacial isostatic modelling and ice-sheet reconstructions from the British Isles since the Last Glacial Maximum. *J Quat Sci* 21:585–599. doi:[10.1002/jqs](https://doi.org/10.1002/jqs)
- Sirelius UT (1906) Über die Sperrfischerrei bei den finischugrischen Völkern. Helsingfors
- Smit H, Kop R, Westmacott S (1997) Strategies to combine the functions of ecology and navigation in the Scheldt estuary. *J Chart Inst Water Environ Manag* 11:251–256
- Strachan D (1998) Inter-tidal stationary fishing structures in Essex? Some C14 Dates. *Essex Archaeol Hist* 29:274–282
- Tomalin D, Loader RD, Scaife RG (2012) Coastal archaeology in a dynamic environment: a Solent case study. *Br Archaeol Rep*, Oxford
- Townley E (1998) Fieldwork on the Forest Shore: stroat to Woolaston, Gloucestershire. *Archaeol Sev Estuary* 9:83–85
- Trevanthen E (2010) Hampshire aggregate resource assessment: aerial photography enhancement. Results of NMP mapping: English heritage project no. 5783. Cornwall Council Historic Environment Projects, Truro
- Tubbs C (1980) Processes and Impacts on the Solent. In: Natural Environment Research Council (ed) The Solent Estuarine System: An Assessment of Present Knowledge. Natural Environment Research Council, pp 1–5
- Turner R (2002) Fish Weirs and Fish Traps. In: Davidson A (ed) The coastal archaeology of wales. Council for British Archaeology, York
- Tveskov MA, Erlandson JM (2003) The Haynes Inlet weirs: estuarine fishing and archaeological site visibility on the southern Cascadia coast. *J Archaeol Sci* 30:1023–1035. doi:[10.1016/S0305-4403\(02\)00291-1](https://doi.org/10.1016/S0305-4403(02)00291-1)
- Van de Koppel J, Van der Wal D, Bakker JP, Herman PMJ (2005) Self-organization and vegetation collapse in salt marsh ecosystems. *Am Nat* 165:E1–E12
- Van der Wal D, Pye K (2004) Patterns, rates and possible causes of saltmarsh erosion in the Greater Thames area (UK). *Geomorphology* 61:373–391
- Van der Wal D, Wielemaker-van den Dool A, Herman PMJ (2008) Spatial patterns, rates and mechanisms of saltmarsh cycles (Westerschelde, The Netherlands). *Estuar Coast Shelf Sci* 76:357–368
- Van Wijnen HJ, Bakker JP (2001) Long-term surface elevation change in salt marshes: a prediction of marsh response to future sea-level rise. *Estuar Coast Shelf Sci* 52:381–390
- Verney R, Deloffre J, Brun-Cottan J-C, Lafite R (2007) The effect of wave-induced turbulence on intertidal mudflats: impact of boat traffic and wind. *Cont Shelf Res* 27:594–612. doi:[10.1016/j.csr.2006.10.005](https://doi.org/10.1016/j.csr.2006.10.005)
- Viveen WJ, Sanjurjo-Sanchez A, Goy-Diz A et al (2014) Paleofloods and ancient fishing weirs in NW Iberian Rivers. *Quat Res* 82:56–65. doi:[10.1016/j.yqres.2014.04.011](https://doi.org/10.1016/j.yqres.2014.04.011)
- Went AEJ (1946a) Fishing weirs of the River Erne. *J R Soc Antiq Irel* 76:213–223
- Went AEJ (1946b) Irish fishing weirs: I. *J R Soc Antiq Irel* 76:176–194
- Went AEJ (1948) Irish fishery weirs: II—the Duncannon Weir. *J R Soc Antiq Irel* 75:213–223
- Went AEJ (1951) An ancient fish-weir at Ballynatray, Co., Waterford, Ireland. *Antiquity* 25:32–35
- Went AEJ (1969) The ancient “Sprat” fishing weirs in the South of Ireland. *Ind Archaeol* 6:254–260
- Wessex Archaeology (2010) New Forest Rapid Coastal Zone Assessment. Lymington
- West IM (1980) Geology of the Solent estuarine system. In: Natural Environment Research Council (ed) The Solent Estuarine System: An Assessment of Present Knowledge. Natural Environment Research Council, pp 6–18
- Western Solent and Southampton Water Coastal Group (1998) Shoreline Management Plan: Subcells 5F (Part), 5C and 5B (Part). Western Solent and Southampton Water, Swindon
- Wharton A (2008a) Early Saxon fish traps: Barn Elms 1 (Surrey). In: Cowie R, Blackmore L (eds) Early and Middle Saxon rural settlement in the London region. Museum of London Archaeological Service, London, pp 118–119
- Wharton A (2008b) Middle Saxon fish traps: Barn Elms 2 (Surrey). In: Cowie R, Blackmore L (eds) Early and Middle Saxon rural settlement in the London region. Museum of London Archaeological Service, London, pp 122–123
- White C (1956) The role of hunting and fishing in Luvale society. *Afr Study* 15:75–86
- Wilkinson TJ, Murphy PL (1995) The Archaeology of the Severn Essex Coast, Volume 1: the Hullbridge Survey

- Yapp RH, Johns D, Jones OT (1917) The salt marshes of the Dovey Estuary. Part II. The salt marshes. *J Ecol* 5:65–103. doi:[10.2307/2255644](https://doi.org/10.2307/2255644)
- Zayas CN (2011) Describing stewardship of the common sea among Atob fishers of the Pacific Rim Islands: cases from the Phillipines, Taiwan, and Japan. *South Pac Stud* 31:71–80